This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

HARVARD UNIVERSITY

LIBRARY OF THE

GRADUATE SCHOOL
OF EDUCATION

Educ P
433.3
V. 13
1919-20

HARVARD UNIVERSITY
GRADUATE SCHOOL OF EDUCATION
MONROE C. GUTMAN LIBRARY

ENGINEERING·EDUCATION

Bulletin of the

Society for the Promotion of Engineering Education

VOL. X LANCASTER, PA., OCTOBER, 1919 NO. 2

New McGraw-Hill Texts

JUST OUT

HYDROLOGY

By Daniel W. Mead, Professor of Hydraulic Engineering, University of Wisconsin. 600 pages, 6 x 9, illustrated. $5.00 net postpaid. A thorough text-book on the fundamental facts and principles of hydrology.

Daugherty—HYDRAULICS

NEW SECOND EDITION

267 pages, 6 x 9, 245 illustrations, $2.50

A revision of the most widely used modern text-book on the fundamentals of hydraulics.

Still—ELECTRIC POWER TRANSMISSION

NEW SECOND EDITION

403 pages, 6 x 9, illustrated, $3.50

This second edition covers underground as well as overhead systems.

Langsdorf—PRINCIPLES OF DIRECT-CURRENT MACHINERY

NEW SECOND EDITION

In Press

Kimball—PRINCIPLES OF INDUSTRIAL ORGANIZATION

NEW SECOND EDITION, $3.00

Send for on-approval copies now.

McGraw-Hill Book Company, Inc.

239 West 39th Street NEW YORK

The Force of Example in Accomplishment

McGraw-Hill Engineering Publications unroll before the eyes of the student reader a constantly changing picture of the actual accomplishments and practical activities of the men of the engineering profession.

They maintain for him a realization of the practical goal toward which his studies are carrying him.

They illuminate and inspire the work of the class.

That student has already developed a valuable asset who forms at school the habit of regularly reading one of the

McGraw-Hill Engineering Publications

Electrical World
For electrical and mechanical engineering students. It covers every activity of the electrical engineer. Published weekly. $3 a year.

Electric Railway Journal
For students who intend to specialize in the transportation field. Design, construction, operation, management. Weekly. $3 a year.

Chemical and Metallurgical Engineering
For chemical engineers and metallurgists. A great technical newspaper. Semi-monthly. $3 a year.

Engineering News-Record
The acknowledged authority in the field of civil engineering and construction work. Published weekly. $5 a year.

American Machinist
Gives the student an insight into workaday machine design and construction; machine shop management; machine tool operation and methods of marketing machinery Weekly. $4 a year.

Engineering and Mining Journal
Deals broadly and efficiently with the metal mining and metallurgy of minerals other than coal and iron. Weekly. $5 a year.

Power
For students desiring a knowledge of power plant engineering and the generation and transmission of power in all industries. Weekly. $2 a year.

Coal Age
It deals with every phase of modern coal mining and coke manufacture, including the production of by-products; fuel markets; contracts and prices. Weekly. $3 a year.

Electrical Merchandising
Equips the student with excellent working knowledge of the selling of electrical appliances and electric service. Monthly. $2 a year.

McGraw-Hill Co., Inc.

NEW YORK

BULLETIN

OF THE

Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee:

Arthur M. Greene, Jr., John F. Hayford, F. L. Bishop, *Editor*.

Address all communications to the Editor, University of Pittsburgh, Pittsburgh, Pa.

VOL. X LANCASTER, PA., OCTOBER, 1919 No. 2

TABLE OF CONTENTS.

Engineering Colleges and Administration. Ira N. Hollis 33
The Problem Method at the Engineer School, U. S. Army, Camp A. A. Humphreys, Va. C. C. More and W. E. Duckering 69
Editorial 75
Aims of Engineering Schools 76
Letter to the Editor 77
College Notes 78
Book Reviews 80

ENGINEERING COLLEGES AND ADMINISTRATION.

BY IRA N. HOLLIS,

President, Worcester Polytechnic Institute.

It is difficult to write anything new on college administration. A list of papers that have appeared in our journal seems to indicate that the subject is threadbare. Most of our colleges have taken their own way, usually along the lines of least resistance, without much agreement as to methods. A committee of the society was formed either to study administration or to write on the subject, but up to this time little has been done. Perhaps the subject is too complex for any generalization. Education is not like a manufactured article. It cannot be standardized without losing its soul. The success of an institution of learning is so much dependent upon other things than administration that it seems on the whole wise to couple that subject with the whole general question of preparation for the engineering profession.

Education is after all too much a question of the personality and the motive of the teacher to submit itself to well-defined rules, applicable to all cases. What is education? We can easily look up the definition in some dictionary, but is that enough? We must know what we are talking about and agree upon the end to which the education is directed before we can begin to discuss administration. That is my reason for associating the whole general problem of engineering schools with the conduct of their business and with the administration necessary to carry it out.

It is also worth while to define college administration. Heretofore everything outside of the recitation room or of the preparation of lectures has been called administration. One of my amusing experiences was in connection with a very young colored man who told me he was in the administration, when his job was simply helping to copy off marks and to distribute them. As a matter of fact all the business of a university or college is administration. The organization of the faculty and the graduation of the classes year after year all become matters of system especially where the work involves some responsibility and decision. In this paper I am using the word to mean everything outside of actual teaching; everything that interferes with the teacher's giving his entire time to study and to the preparation of lectures; everything that modifies in any way the companionship of a teacher with his students. The business function extends therefore from the trustees, through the faculty and committees, to the handing out of marks and degrees but never crosses the line of the professor's real job, viz., to turn boys into good citizens well able to do the work of the world.

I have referred to the word education and I believe the best conception of it in an engineering school is to treat it as the process of teaching a boy the habit of work and a habit of thought in conformity with the times, or in some cases, in advance of the times. The main thing to be considered about education, however, is that it is not confined to the four years of college life which at best is only an oasis in the years of three score and ten. We all know that an engineer's training does not end with his degree. That forms only the commencement, and yet we rarely live up to our knowledge of this plain truth; for we generally shape the four years of study as if the young graduate were going to enter at once upon his practice as a full-fledged consulting engineer. Our Society has not had the influence upon education that it deserves and that it might have had under a more definite and outspoken program.

Few engineering schools have ever had the courage to take the plunge into a curriculum less closely connected with the commercial needs of the student immediately after graduation, and for that reason the engineering profession is often little esteemed. In the thought of the public it ranges from the blue-print boy in the drafting room to the man who holds the responsibility for building a great waterway, a great battleship or continental railroad. There is evidence among our own members of vague and unsatisfactory classification. The American Society of Civil Engineers is a well-organized association of experienced and capable men in our profession. There is no room in it for young draftsmen. A member must have demonstrated his fitness for directing important work. The American Association of Engineers founded a few years ago in Chicago is essentially a union not unlike the federation of labor for the benefit of its members. I am not trying here to make an argument for or against either of these two engineering societies, as wide apart as the poles in some of their ideals. But, which one of them represents the end to which we as teachers are aiming? Undoubtedly draftsmen are needed and are useful in the work of our profession and some men will always remain draftsmen. With equal certainty great engineers will spring out of the obscurity of small places and small schools; but which type shall our engineering schools prepare to educate? Does the draftsman come from a school of a lower grade than the finished engineer or is the drafting room simply one step between the technical school and the profession of engineering?

About twenty years ago an old gentleman in Boston who had inherited and increased a great fortune, obtained through the work of engineers, expressed the view that engineering colleges should be organized to train routine men; that is, men to fill subordinate positions. While his money had come through the work of engineers he was voicing simply the desire and understanding of many trustees and founders of technical schools in America. They wish to provide the kind of men turned out by the German technical schools of the lower grade. It must be confessed that, while our professors have not this thought, the effect of their teaching and organization has been to carry out the idea of graduating men for a professional trade, and our four-year courses have in many cases amounted to simply advanced vocational training. In a few cases there has been a distinct recognition of higher education but in the main the organization has been planned for the graduation of engineers as young and as speedily as possible.

The articles upon administration appearing in our Journal during the past few years have usually referred to the efficiency of education as appears from the following brief list:

1. "Efficiency in Engineering Education," by Henry S. Munroe. (1910.)

2. "The Application of Scientific Management to the Operating of Colleges," by S. Edgar Whitaker. (1912.)
3. "Operating Engineering Schools under Scientific Management," by H. Wade Hibbard. (1912.)
4. "Scientific Management in College," by Earl F. Palmer. (1912.)
5. "Academic Efficiency," by H. H. Person. (1913.)
6. "The Relation of the Administrative Department to the Teaching," by C. R. Mann. (1914.)
7. "Academic Efficiency, Undefined and Unrewarded," by L. M. Passano. (1914.)
8. "Efficiency in College Administration," by S. B. McCormick. (1915.)
9. "A Plea for the Further Study of Efficient Methods in the Administration of an Engineering College," by C. C. Morris. (1916.)

Efficiency like a medicine must be taken in proper doses administered by a wise doctor if it is to have its high usefulness to an institution of learning. Wherever it takes the soul out of teaching or makes the records and the systems of more account than the actual education of the student, efficiency is worthless. We have an example of that in the organization of an entire nation to do its work and to secure a place under the sun. No nation has paid so much attention to the careful selection of men for the paths that have been marked out for them by a ruling class. The German method was introduced into America years ago and we passed through a period of worship of everything German from the workshop to the university. As a matter of fact their efficiency has betrayed the Germans into a false conception of their mission on this earth and into an entirely unnatural opinion of their relation to the Almighty. We find the professors in Germany throwing the truth to the dogs in order to assist Germany in obtaining dominion over the world. They have appealed to the passion of their countrymen to promote the ambition of themselves as super men. There is no greater curse to a nation or to an institution than the blind worship of efficiency. The word has a high and fine significance when properly applied to the development of men and women.

"There is one glory of the sun and another glory of the moon and another glory of the stars; for one star differeth from another star in glory." Something similar may be said of efficiency. There is one kind of efficiency of the hand, another of the body, another efficiency of the mind or brain and another of human beings when acting in the mass. Yet they are inseparable in their influence upon civilization and happiness just as the glory of the moon is inseparable from the glory of the sun. We as teachers have separated them, but mainly through inability to look upon education in a large enough way. We must define then what we expect to attain before we can lay down even the trace of a road towards proper efficiency. We are in a position like that of a gunner who is firing the long-range shell at an invisible target. Calculations, and study, and allowances must be made and then the gunner cannot be certain that he is going to hit.

The schools of engineering are all trying to produce citizens who through their education and training are efficient in hand, body and mind. Any plan that sacrifices one of these to the other takes away from the value of our system of education. It may be well enough for a manufacturing concern to promote skill with the hand but we cannot limit ourselves in that way. The production of an article of commerce by a system that will either make the most money for a corporation or sell at the lowest price in competition with other corporations has been called efficiency. The development and use of the maximum amount of our natural resources has also been called efficiency. No writer has ever seemed to think of the finest thing that nature produces, men and women, as being the object to which efficiency should be directed. Any reduction in the cost of an article, in the time and effort to produce the article, without taking into consideration the human relation of labor to our whole social life, leads to a one-sided view of efficiency. What is the good of a cheaper article if strikes are promoted? What is the good of anything in our modern industrial system if we are kept eternally on the rack? To-day no one knows what is coming out of the readjustment period following the war, mainly because we have had only a one-sided view of efficiency. Few manufacturers have ever directed their attention to the proper education of their own workmen in ordinary everyday economic truth. I refer to this whole question here not because it is entirely pertinent to the subject under discussion but in the hope that we may not overwork efficiency in our effort to improve the engineering schools.

It would be a mistake to dwell too much on the material side of education. In colleges attention is often called to efficiency in the use of rooms, efficiency in the use of laboratories, efficiency in the hour plan. Seldom is attention called to that organization which serves to make men. Any system is good that will permit the teacher to do his work and to maintain that happy relation found in the term—master and pupil. One has only to go back to the fourth and fifth centuries before Christ to find in Greece exactly that relation under which Athens developed in the leadership in art, literature, the drama, and even in the origin of science. We still go back to that fifth century as the fountain head of everything that we have, and it was done mainly through the schools such as that of Socrates and his pupils, of Plato and his disciples, of Pythagoras and his secret society on mathematics. Furthermore, the best that we have to-day in real teaching is the relation of great masters to their pupils. It may be said that there are few great masters. There would be more if our organization of colleges would only permit the type of teaching and class-room work that form a fruitful soil. I consider Mr. Taylor's work on system in manufacture, called "Scientific Management," perhaps the most important contribution that we have had in industrial science during this generation, because after all our principal development concerns great masses of people. At the same time it is very easy to carry a system too far, especially when applied to a department where it cannot be made to fit. Scientific management in college education is absurd. We all know that there are faults and we all strive to correct them but we also know that in the relation of man to man and student to professor there is no such thing as scientific management.

I should like to make a confession here of views that have gradually become convictions in the twenty-six years that I have been in teaching at Harvard College and the Worcester Polytechnic Institute. What should be the relation of a teacher to administration? I look upon a good teacher as the best that a college can offer. The teachers are of far more importance to a university or college than even the graduate body or the students themselves, because their influence is felt far beyond the academic walls. It is to them that the graduates and students and the public look for the maintenance of our ideals in America, and it is their influence joined with that of the ministry that is the most far-reaching. A man of high character and fine human qualities in the classroom is so far superior to any system of administration that the routine of study is soon forgotten under the influence of such a teacher. There should be as little administration connected with such a man as may be consistent with carrying on the business, to the end that teachers may not be distracted from what is the main purpose of their employment. When a graduate carries into practical every-day life the memory of his association with an unselfish friend under whom he sat in the classroom he has a lasting and real influence for good.

We have lost a sense of true values in the intense commercial struggle of this century and in America we are too quick to look upon a transfer from teaching to administration as a promotion. It is a great misfortune to a college and to the teacher himself if he is taken from a highly successful relation to students to be put into administration, however well he may develop therein. I well recall in the life of one of my friends the gradual lapse from teaching and investigation into the business of a large university department, and I cannot help but feel that while the university gained a fine efficient man in its business the world lost one of the best investigators and inspiring teachers I have ever known. Who could imagine a man like William James, or Longfellow, or Rankine, or Weisbach, or Rowland, or Aggasiz, expending his thought and effort on details of administration? It may be said that such men are exceptional. They are, and it is our misfortune in the teaching profession that they include no engineers, and that they will become more exceptional in our present commercial attitude towards all education.

It has sometimes been suggested that we do not make a proper statistical study of education and that therefore we lose efficiency. It might very well be asked, who is to make the study? I have in mind the kind of an investigation that was started in one of our great universities many years ago to determine the effectiveness of the university teaching. A questionnaire was sent out by the business office calling for information on all kinds of activities. The thing finally became a joke because some of the best-known teachers in this country were asked for the number of hours in the class room, the number of hours required for direct preparation of subjects to be presented to students, and the number of hours required for indirect preparation. Can any one picture the attitude of mind of Mr. James when he was called upon to tell a clerk the number of hours of indirect preparation for his lectures on philosophy? You cannot measure teaching by statistics. The influence of a fine teacher is something beyond price and the determination of class-room contents, standardization, the number of recitations a week, the cubic feet of air for each student, and other factory equivalents seem ridiculous when measured up against the services of master to pupil. Some reports have been published by the Carnegie Foundation and yet in all these matters relating to efficiency I have been struck by a certain futility. One might as well take up the ideals of a people by counting the number of hours of attendance upon church in the course of a year, the number of square feet per christian attending, and the salary of the preacher per member of the church. As a matter of fact teaching cannot be standardized in its highest sense. It is better to tolerate some waste of money than to permit the morale of the teaching force to decrease and in that way to encourage waste of real brain matter.

Success in teaching is measured by the seriousness of purpose of the teachers themselves. We all know of course that certain sides of administration can be treated very much as the management of a factory. Care of buildings and grounds, the upkeep of apparatus and materials so that they will not deteriorate, and the procurement of materials needed for the laboratories, would classify themselves naturally under some kind of scientific management because the teacher's time ought not to be occupied with administration details any more than is absolutely necessary. Therefore, some kind of a business management ought to be devised to assist them and direct the time of the students. How many college teachers of any quality are there in the United States who will work under a system of scientific management directed by men who have no share in the teaching? There are very few. There ought to be some rules but the chief end is to educate a boy or girl and to make a first-class citizen, not a machine that has been through a shop and perfected by a certain routine method or for a certain definite purpose. Administration may well be directed to one point and that is the payment of professors so that they may have enough to live on with leisure to think about their profession. That is a fundamental question before the American people. If it is answered properly, good men will turn naturally to the teaching profession instead of turning first to commercial positions as giving them a better chance to bring up their families. We have too many cases of poverty among teachers.

The tendency of modern times is towards scientific methods. Everything is reduced to a statistical or tabulated basis and it does not seem to be worth anything unless placed on the ordinary rectilinear curve. It is a good thing in any country to get rid of illiteracy and to train every youth to do something so that his hands may not be idle but any system that shrivels up the soul is essentially bad for humanity and for the individual. Furthermore, any development that lacks the spiritual element renders science a real danger to mankind. We have evidence of that in this war. I have asked the question in another place "Is science safe for human beings?" It has been used for the last four years in destroying property and in shedding the blood of the finest that our nation has produced. Every invention and energy has been put to making science destructive rather than constructive. We have the element of danger always before us by putting into the hands of a few unbalanced extremists power to destroy men, women, children and property. The newspapers are filled with stories of crimes perpetrated by those who have used science without conscience. What gives this whole Bolshevik movement its hold but science combined with ignorance and a lack of conscience? Our ideals in engineering education should take account of this fact and the system should be primarily a training in conscience and the will to do right first, and then a technical education.

It is well worth while to review briefly the types of organization to be found in education. Reference has already been made to the most flourishing period of Greek history when the Greeks rapidly came to the front in everything that lies at the basis of human life and happiness. The only thing they did not have was the example of Jesus Christ but Christ patterned his methods on that of the Greek schools. A man like Socrates would set up what practically amounted to a course of lectures in the market place or elsewhere and his disciples would follow. Education has never flourished as it did under those men. There was no thought of efficiency or system or organization—it was master and pupil or master and disciple. This type of school has extended down to our own times. It is what is meant by the saying that Mark Hopkins on one end of a log and a student on the other constitute a university. That seemed to be Mr. Agassiz' theory when he went in 1847 as a professor to Harvard College. He practiced exactly that type of teaching—master and disciple—and under him natural science immediately became popular in the United States. His pupils have been marked men especially those who studied under him in the little old wooden museum at Cambridge. Every one of them achieved distinction. There is an example of this in the German universities where the professor gives his lectures to those who choose to enter his courses. In a university, where there are many professors and many students some system has to be adopted so that the lectures are not all given at the same hour. Organization and administration, however, are never concerned with the class-room work. That is entirely a function of the professor. Even in the technical schools of Germany something of this idea prevails. I well recall some lectures that I attended in Charlottenburg when I was making a study of the German technical school system. One lecture on the compound engine was given by a professor who invited me to go into the class room with him. He was polite and there he introduced me to the two hundred and fifty students sitting in front of him. The lecture lasted one hour and a half. There was no textbook, no record of attendance, no conversation with the students. The lecturer simply went into the room, gave his lecture, and then walked out, the students being left to do the best they could to study up on the subject through text-books that they found in the library or elsewhere. I do not recall even any conferences with the professors and I did not see such a thing as a recitation. The main evidence of administration at Charlottenburg was the annual report written by the rector.

A modification of the German system was found at Harvard University under the unlimited elective system where a student could take practically what he wished and graduate after four years of study, having completed seventeen and a half courses. This system has been modified so that all students are required to concentrate on a major subject and to skate around many minor subjects, but at Harvard the attendance was taken and there was some requirement as to annual examinations. The proposed new system at Harvard is to have examinations at the end of the four years of study on all the major subjects that students have taken. This means of course that no student can get through without a good general knowledge of at least one subject. Of one thing a visitor at Cambridge might be certain—he would find the class rooms of professors crowded if the lectures were presented by a man of real gift.

The most organized type of higher education is found in the prescribed systems of small colleges. They used to be classical and some still are classical but we have added all kinds of up-to-date subjects in most cases with a little election during the junior and senior years. Engineering schools, however, have as a rule a rigidly prescribed course of study beginning where the high schools leave off and continuing through four years gradually becoming more and more professional. Usually the first year is the same for all branches of engineering and the last year is exclusively technical.

The net result of this preliminary consideration brings us to the question, What is the place of an engineering school and what should it acomplish? This has a very direct bearing upon its administration. Another question might be added, Must there be only one type of engineering school? It seems to me foolish to lay any stress on the method or type as being the final word. No engineering education can be standardized without running the risk of losing much that is valuable in the individuality of different teachers. As a matter of fact most men make themselves and a course of study has little to do with the magnitude of their careers. Often it has nothing whatever to do with their occupation in life. Any school will prove this fact and make plain that a man's chief education comes with experience in life and from study after graduation, sometimes retarded by a course of study which has to be unlearned. The man's education, however, must be his own if he is to achieve any distinction whatever.

I take as an illustration of a rigidly prescribed course, the United States Naval Academy, because I am familiar with it and because it is one of the best examples of a curriculum that has no elasticity. In the first place it is strictly utilitarian in the sense that no attention is paid to anything that does not count towards the training of a naval officer for sea duty and for a limited number of international problems that may arise between our country and foreign nations. Everything that does not find a use is excluded. There is no great attempt at real teaching. It is a ''sink-or-swim'' method. The lessons are given out and the midshipman must learn them for himself or fail. It is really a case of intensified training and discipline and then of careful weeding. Our courses in engineering schools must necessarily be on a broader basis because we never know beforehand just what branch of the profession our graduates are going into. That often is a question of opportunity and the industrial condition of the country. Nevertheless the great majority of engineering schools are like the Naval Academy minus the discipline. The Navy always knows what its graduates are going to do and the energies and organization can therefore be directed to that one thing—to make men for the best fighting machine in the world and to fulfill its purpose and function better than any school in the United States or perhaps in the world. Theodore Roosevelt once told me that he considered the Naval Academy the finest school in the world, meaning by that that it carried out its function better than any place else in doing what it set out to do. And what is the result? It produces good officers who have shown in this late war their capacity to work efficiently and enthusiastically. But it goes further in that it graduates a large percentage of men who leave the Navy and go into other professions entirely outside of the course of study. They obtain their education for their work on top of the Naval Academy training which is valuable only through its discipline. It is easy to show what graduates of the Naval Academy have been capable of doing by simply naming a few of them: In history, Alfred T. Mahan, who opened up a new field for historians. In literature, Winston Churchill, Cyrus Townsend Brady, whose novels most of us have read. In invention, Frank J. Sprague, the father of the trolley system. In education, Mortimer E. Cooley, who built up the first great engineering department in a university. In business, Homer L. Ferguson, lately elected president of the U. S. Chamber of Commerce.

It is not intended here to give any list of the graduates of the Naval Academy who have distinguished themselves outside of the Navy and the purpose of this reference is only to show that men who have acquired the power of application and the initiative to do something with themselves are not dependent in any way upon the curriculum of any school, its organization, or its administration. They find their chief stimulus either within themselves or from teachers like Louis Agassiz. We get back then to the question asked before—What is the purpose of an engineering school? It is to train a large number of men for the ordinary business of engineering, leaving to the exceptional who are capable of striking out into new fields the education of themselves. An engineering school may well have a semi-military character as the student is to graduate into a profession requiring system and accuracy but it does not follow that he must be turned into a machine by methods reduced to a standard.

We have certain illusions in our schools. One of these is that a teacher of engineering is a great asset if he continues his activities in the practice of his profession. As a matter of fact he is often a brake upon the development of first-rate teaching. If he is a good teacher, the time spent in outside business is a distinct loss to the institution with which he is connected. There is a lot of loose talk about keeping up with the advance of science and its newest applications. We in engineering education know that the fundamentals are more important than anything else, and that the best method of keeping up with the times is to learn the best method of presenting fundamentals, not of keeping an array of facts before our students, even though these facts spring from the latest investigations. A man cannot ride two horses except in the circus ring. The work of an engineering school is far more fundamental than the latest advances which in their turn in a very few years, often before the young graduate has really gotten into his profession, become the antiquated practice of a rapidly receding past. We are in the profession of teaching and time spent in studying the methods of presenting a subject to students is far more valuable than the same time put into practical application. America has been a partial failure in its engineering schools because it has developed very few writers of first quality. Our books are usually slipshod, prepared at odd hours between the preparation of lectures and the practice of consulting engineering, simply because our teachers have been encouraged to supplement their insufficient salaries by outside work. We are thus in the habit of flattering ourselves with the thought that we are keeping up with the times. The only really practical advantage in a teacher's connection with outside work is that he stimulates the imagination of his students and in that way obtains from them a larger measure of effort and interest.

Another illusion that is common to colleges is that the subjects taught in an engineering school must necessarily be less broadening than the subjects in non-professional colleges. That is not true of the engineering school that devotes itself mainly to fundamentals. There is not a subject fit to be taught in a technical school that cannot be broadened and enlarged to make it a real education. In 1893 the engineering courses at Harvard College were completely revised and every one of them, except the workshop courses which were almost exclusively hand work, were accepted as part of a liberal education for the A.B. degree. This was freely granted by the teachers of classics and others on the Harvard staff. Unfortunately all teaching for the profession of engineering was given up when the agreement was made with the Massachusetts Institute of Technology.

The administration of a college differs ordinarily from that of a business corporation in that it must be more democratic and must take more account of the wishes of those who are employed in its service, and the teaching force must be consulted and controlled only so far as to hold the institution together. A good teacher can always do his best work when free to direct his energy in the manner he considers most advantageous to his students and in a way that will develop his own thought as well. His profession confers upon him responsibilities and privileges on economic, social and scientific questions sometimes difficult to reconcile with the views of boards of trustees; hence the discussion of the words "academic freedom." On the whole it is better that a teacher should be free to discuss any subject so long as he does not disgrace himself or degrade the institution, and this applies to engineering schools as well as to the larger universities. When we contrast the behavior of our professors under a system that does not put restrictions upon them or require any special doctrine to be taught with the behavior of the German professors and their betrayal of both profession and country in the support of military Prussia we must find a real reason for congratulating ourselves upon the freedom of thought in the universities, colleges and technical schools of our country. Fortunately we have no privately endowed institutions that have any tendency to inflict upon their teachers a particular political partisanship or any phase of academic doctrine.

College administration must take account of the fact that the highest aim in any school is enlightened citizenship in this republic, in addition to the specialties for which the school is founded. In this regard we sometimes are tempted to separate the technical school from the ordinary college but the purposes are not essentially different and we may better emphasize the likeness rather than the differences. An engineering school is intended to supply a young man with at least the introduction to a profession as well as his general education, while the college attempts merely a general education as a basis for subsequent professional study. Attention has already been called to the fact that most of the subjects in an engineering school if properly taught are capable of being broadened out into a general education. It is entirely a matter of emphasis and the personality of the teacher. We hear much of the broadening of a great university and yet the broadening springs largely from the fact that the university has money enough to employ teachers to whom a large amount of leisure for thought and study is given. A good man has a broadening influence without much regard for the subject that is taught. Greater consideration ought to be given to the type of man who is teaching. A really inspiring teacher could make of a course on steam pumps something vastly more effective even in the teaching of English than a young assistant of no experience in life could make out of the teaching of English itself. Let us remember this in connection with administration of colleges and in the selection of teachers.

A study of administration may be taken up on a considerable scale by assembling and classifying all college catalogues, but I find this method comparatively fruitless. It is better to make an examination of comparatively few typical cases remembering that the personality of the men in the administration has far greater influence upon the results than the exact organization itself. Consequently I am concerned here mostly with the kind of administration under which teachers have the greatest amount of freedom and under which the student finds the greatest stimulus to study.

All the activities of an engineering school may be divided among comparatively few heads.

1. *The Financing of the Institution.*—This is a matter largely for the trustees and for the friends of the school, and it should not be a part of the work of the teaching staff. No fixed rule can be made inasmuch as privately endowed

colleges must get help where they can through teachers or anybody who is effective. There is one matter to which the most scrupulous attention should be paid; viz., that the income from funds should be used so far as it is possible exactly for the purpose named in the deed of gift or in the bequest. If there is one place on this earth where the truth should prevail and where a benefactor should obtain exactly what he requests, it is a college. Truth and honor should be maintained at the expense of refusing some gifts.

2. *The Plant and its Maintenance.*—This is a business matter similar to that of any commercial establishment. The principles of scientific management may very well be applied in the care of buildings, laboratories and all property of an institution of learning without in any way interfering with the relation between professor and student. The business side of a college should not be put upon the members of the teaching staff if it can be avoided; at the same time a superintendent or agent should hold his position only by his acceptability to teachers, his understanding and sympathy for their work.

3. The use of rooms and laboratories, the hour plan of recitations, the penalties and rules, and the physical training, all of which constitute faculty business, to go before the trustees only where they involve money or question. So far as possible the faculty business should be committed to standard committees on discipline, on records and on the enforcement of rules. It has been customary in the past to carry cases of discipline to the faculty but it is of doubtful wisdom except for the information of all teachers; even dropping a student for being unsatisfactory in his studies can be made a function of some committee.

4. *The Teaching in the Class Room.*—This is always by means of lectures, demonstrations, recitations or conferences and will form the purpose for which a school is established. This must never be lost sight of. All organization leads to this end and to nothing else.

5. *Relations with Students Outside of the Class Room.*—

This is so much a matter of informal daily contact between professor and student that no rules can be laid down. It will always be dependent upon the temperament and sympathetic understanding on the part of the teacher and it is possible that this beautiful relation may be the best thing that a student gets out of his college life. The fine service that goes to build up a boy's character is more an asset for citizenship.

6. *Student Activities.*—A college that does not encourage in some way student activities outside of the class room becomes too rigid and it does not produce a type of graduate who can adapt himself to the conditions of everyday life. Some religious schools are of this kind and many engineering schools over-crowd students so much that they have no time for what might be called a course in human relations and friendship.

I have no intention of dwelling on these matters. They have to do with administration only so far as the background is naturally made by the governing boards. The first three of them relate entirely to the business of an institution and the last three to the education of young men. The whole purpose of this paper would be misunderstood if it is interpreted to mean that I do not believe in efficiency and good business administration. I do most heartily believe in both and in a proper organization but never at the sacrifice of that human relation which does more to turn a boy into a good man than all the organization in the world. I have dwelt on the word efficiency because we have made a fetish of it. Of course we all know that an engineering school is primarily an institution for teaching engineering and for giving a young man his start in the profession. Consequently the primary purpose relates to science and the things that a student must learn form part of the profession. That is first and organization should have that in view, but again I repeat, never at the expense of the soul.

Every college has its board of trustees, sometimes called a corporation, a board of regents, or simply a governing board. It makes no difference under what name this board appears it must necessarily take responsibility for the institution. There are two types of organization of trustees; one is a single board like a business corporation, and the other is a dual board like a business corporation with a senate that must pass upon its acts. In some cases these boards are elected or appointed and serve for a term of years. In most cases, however, the members hold a life tenure and the board is self-perpetuating. No two colleges are managed in exactly the same way and there are many types of boards. In order to bring before the Society a complete exposition of this matter it would be necessary to exhibit the framework of every university and college in the United States. They may be divided as above into two types, a few examples of which will be sufficient. The old style college still exists in places like Bowdoin, Amherst and Williams, and they fill a very useful place in our system of education. They have their board of trustees made up in part of ministers and in part of business or professional men elected with a life tenure. We are not concerned with these so much as we are with those that have engineering departments or are solely planned for engineering education.

Yale University has a corporation consisting of the president and fellows, in number nineteen, elected either for life or for a term of years. The Sheffield Scientific School has also a board of trustees of nine members. This board is a corporation, three of whose members are ex-officio, viz., the governor of the state, the president of Yale College, and the chairman of the Peabody Museum trustees. The other six hold a life tenure and fill their own vacancies. The director of the Sheffield Scientific School is the secretary of the board. It will be observed that the graduates of the Sheffield Scientific School have no voice in the government excepting so far as they may be chosen by the surviving members to fill vacancies. The organization at Yale will probably be affected by the general discussion now going on.

The Case School is apparently incorporated and is held by a corporation of twenty-two members. The business of the institution is directed by a board of trustees consisting of seven members chosen by the incorporators. The graduates would have no voice excepting as they are chosen to be trustees, and the president is not a member of the board of trustees either by election or ex-officio.

Rensselaer has a board of trustees consisting of twenty-three members holding a life tenure and the mayor of Troy as additional ex-officio. The president of the institution is also president of the board of trustees and the graduates apparently have no voice in the choice of the members. This case is much like the old-time board of trustees for colleges.

The Massachusetts Institute of Technology has a corporation consisting of fifty-three members, the president, the treasurer, the secretary, the governer, the chief justice, and the commissioner of education, all of Massachusetts, being ex-officio members. There are thirty-two life members and fifteen term members, three being elected each year for a term of five years. There is besides an executive committee consisting of the president and treasurer and five members who are chosen by the corporation from among its members for a term of five years. This committee has power in all appointments and fixes the salaries and duties of all officers. It has entire responsibility for all the property of the institute. The fifteen term members of the corporation are elected by the corporation from a group of candidates submitted by the alumni of the institute. The corporation as a whole confirms appointments, confers degrees and authorizes certain financial transactions.

Harvard.—The government of Harvard is by two completely independent boards. The first board is known as the corporation, consisting of the president and treasurer and five fellows, called usually the president and fellows. The members have a life tenure and vacancies are filled by the surviving members. This corporation transacts all business, makes all appointments, and in general may be regarded as the directors of the institution. A second board, called the overseers, consists of thirty members. Five of these are elected every year for a term of six years, at the end of which time they are eligible for one more term of office. The board of overseers approves all appointments without limitation as to the time and in general takes up questions of policy submitted by the corporation. The president of Harvard is chairman of the corporation but is not a member of the board of overseers.

Michigan University.—This university is a fair type of the larger state universities although no two of them have exactly the same plan of government. Michigan has a board of regents consisting of twelve members. Of these the president, the treasurer and the secretary, and the superintendent of public instruction, are ex-officio members of the board without vote. The other eight members are elected for a term of years by the people of the state and apparently form a committee to direct all the educational and business affairs of the university.

Other universities and colleges have all kinds of modifications of these six plans. The general tendency is towards a greater participation of graduates in the affairs of their alma mater and ultimately the colleges will probably be governed by the alumni asociations. Furthermore, the dual organization is probably better adapted to private schools than it would be to state universities whose boards have a limited tenure of office. A permanent board is likely to become more or less inactive in course of time, especially if there be associated with it one or two men who carry the financial burden on their shoulders. It is not a sign of prosperity for a school to possess some interested individual who is ready to step forward to pay all deficits. As has already been stated, the character, interest and personality of the men on the board of trustees is of far greater importance than the exact type of organization and the same thing holds with regard to a faculty. Every one of the different schools may have its own individuality without necessarily having inferior methods. The important thing is the man who is sitting in the classroom chair, it is his influence that will tell upon students in the long run. The relation between the board of trustees and the faculty is important. Often the trustees, who are business men, cannot be brought to take a real, intelligent interest in the work of the class room. Occasionally they take too much interest and meddle with the teachers. There has been for years a discussion about giving the faculty a share in the government of an institution and sometimes teachers have felt that the president of a college has altogether too much power. Some reports have been drawn up on this subject. It would seem to me unfortunate to have the members of the faculty pass upon a number of questions that now belong peculiarly to the trustees. I do not think that any professor can possibly be in a comfortable position when he is passing upon the salaries of his own colleagues. This is true even in the departmental government of a college where the head of a department assumes to decide the salary and work of a teacher associated with him.

It would be useful to have occasional meetings of trustees and teachers on certain larger questions of policy like entrance conditions, the courses of study as they ought to be given and the enlargement of the curricula, but when it comes to the actual share in the executive management of an institution the teacher is in a totally false position. His time would be taken away from the essentials of his profession and put into chores. The grievances expressed by some faculties are largely in the nature of appointments and dismissals. It is perfectly obvious that a man who is appointed a professor should be acceptable to his colleagues unless some reorganization or reform is absolutely needed to better a bad situation. Consequently, the appointments in any department ought to come by recommendation or consent of the appointee's future colleagues. If such recommendation comes only from the head of a department, it might as well come from the president of the college. In the matter of dismissals a professor who has taught for many years ought not to be lightly dismissed and the whole subject ought to have full investigation by the trustees. I have heard many business men say that teachers were employees in the same sense as men in the industries. They are often treated in exactly that way but I think it is a great mistake. The profession of teaching is like the ministry a privileged profession and a man who has taught twenty years is in the same position as a preacher in regard to the outside business so that if he is dismissed he is comparatively helpless. I have known a few preachers who have turned to soliciting life insurance as a means of getting a living and there is no more melancholy sight in the world than an old teacher who has no support. As a rule the pay is not enough to enable teachers to lay by any money for their old age, hence they cannot be treated as to appointments or dismissals in the same way as a man in a business position. The value of a teacher's work is very rarely measured by his pay as will readily be disclosed by the great variation in professors' salaries. They vary from $1,500 per year up to $7,000 or $8,000 depending upon the institution, and yet a professor in a small college probably does as good work with his students as those in larger ones.

The Carnegie Foundation has provided a method of taking care of the most serious cases of breakdown in the college service and of getting rid of those whose usefulness has passed by reason of illness, or old age. In future the Foundation will not have so great a power in the matter as it is changing to a type of insurance company.

One often hears the statement that professors are not business men, as if that were a reproach. We may be thankful that they are not. Let us have in America some place and some profession that is not commercial so that we may at least preserve the finer ideals of our forefathers. If a teacher is a good business man he would better go into business and let teaching alone. If he is a good teacher and is capable of stimulating a higher type of character in the student, he ought to give up all thoughts outside the class room. If he is neither he might better be on a farm.

What is the place of a president of an institution of learning? Few of the foreign schools have any such organization as we find in the United States. In England and Germany there is no such thing as the president of a university or college in our sense of the word. The head of the Charlottenburg school is a rector appointed by the government for one year. All appointments to professorships are suggested by the faculty, usually three names are handed in to the government and from these one is selected by the minister of instruction. If none of the three names are satisfactory to the government, three others are submitted until a man is obtained that the minister of instruction will accept. While this apparently is a democratic and open method of appointing professors it really does not differ from the American method of going after the man that is wanted. The president of a college in the United States holds a position very largely as business manager in addition to being at the head of the educational side of the university or college. But his position is often distinctly inferior to that of a teacher who has leisure to study and write. The position is not, however, that of an autocrat as the holder must remain acceptable to the trustees, must find money to run the institution and must be able to convince teachers. On the whole it would be better if the president of every college were the disciplinary officer and had the care of scholarship and loan funds. Whether a changing head such as that in Germany would be good or not in the United States has never been thoroughly tested. The University of Virginia gave up an old system to have a regular president. Probably the present practice of electing a president into whose hands is placed the business and educational matters of the institution is well adapted to the American mind and cannot readily be changed. One of the difficulties with the position, however, is that often too much business is put on the shoulders of the president who has no time for educational matters. This fact has led in many colleges to the appointment of a business agent or a publicity manager to serve with the president in certain business matters outside of the teaching field. Only the larger universities have money enough to separate business from teaching. The tendency of business agents who do no teaching, however, is unfortunately towards commercial methods. Especially is this true of publicity men.

The method of bringing colleges to the attention of the public and bidding for students is very much the same as we find associated with the sales department of any manufacturing company. In some parts of the country the college drummer is sent out to get trade and all kinds of publicity propaganda are devised to lead students to attend the colleges advertised. I believe this to be altogether bad. It may be said that more young men are thereby induced to educate themselves but I do not believe that to be true. A large number are misled into thinking that they ought to get a college degree than are helped by the advertising method. Should engineering schools advertise at all? It is doubtful. Their publicity ought not to extend further than a good description within the catalogue of what the college offers. We ought not to acquire the competitive spirit so much that we shout with joy if we can only show a few more students than our neighbor who is also teaching engineering. The newspapers are filled with stuff of that kind from the larger universities. It usually emanates from publicity agents who are employed to keep the institution before the public which is often deceived as to what the colleges are really capable of offering young men. One of our colleges has a publicity agent who is going out to get 400 more students. The pamphlet by which these students are to be obtained has the same misleading quality found in advertising departments of business houses and represent to my mind the last state of degradation in education. There would be a distinct gain if all engineering schools and engineering departments would join to offer within the same binding a brief description of their names, purposes and work. This could be sent out all over the country and would serve the purpose of indicating the opportunities for education in our profession.

How should a faculty be organized? Undoubtedly the best method of doing business is under some kind of departmental government. An engineering school has naturally certain important departments like civil, mechanical, electrical and mining engineering, chemistry and perhaps architecture, each one with its staff consisting of a chairman, or head of a department, and the colleagues who join in carrying on the work of the department. It is bad, however, for any college to have too strong a departmental organization or to have one department overtopping its neighbors. Rarely can the most effective coöperation be carried out under such a system. It has always seemed to me better to have a head of a department chairman for a term of years and to have the office changing occasionally so that the chairman of the department becomes largely the mouthpiece of the professors and not the director of their work and their energy. In many colleges, departments constitute what an officer in the War Department has named a parallel organization with every bureau having full authority and no person or persons having wide professional knowledge to reconcile differences. A certain amount of emulation and competition is useful but pigheaded obstinacy or jealousy in the maintenance of one department against another is destructive of efficiency and business in a college as in the government departments.

The faculty is necessarily divided into committees for the admission of students and for supervising their work. It is almost imperative that every faculty should have as one of its committees an administrative board, whatever that board may be called, to see that the students keep to their tasks and, if they do not, let them know about it. This is really a friendship board as well as a disciplinary board because through it the students are assisted and their delinquencies are called to the attention of the faculty. A third committee is useful in any faculty—that relating to the organization of courses and the schedules leading to a degree. These three committees necessarily form the backbone of any organization, other committees being largely subordinate and effective only for short periods. It has sometimes been said that the president of an institution ought to be a member of every committee but that seems to me unnecessary. He ought to be a member of only the committees on which he can be useful. Sometimes it is a positive disadvantage to have him a member of a committee because the member in that way lacks freedom to make up their own minds in their own way.

The arrangement of hours for lectures, recitations and laboratories commonly called the hour plan for students often presents great difficulties. It becomes almost impossible in a large university when the engineering instruction has to fit in to a long-established plan for academic study. Exactly that happened at Harvard when engineering was reëstablished in 1893. For that and other reasons the engineering department of a university must be separate from the academic department. In most cases even the language and mathematics must be given separately, thus establishing a school by itself in an alliance with the academic department, the law department and the medical department. Its methods and its purposes become thus almost the same as those of the ordinary technical school. As a rule the hour plans are too unsystematic and often demand very irregular hours on the part of the student and of the instructor. It would be worth while to make a better study of this for technical schools generally. The Naval Academy had for many years a plan of two hours assigned to each subject. This meant 8–10, 10–12, 2–4, every day. Classes were arranged in small sections having recitations one hour and then one hour for study in each of these periods. The ordinary civilian college might have something of the same arrangement. At the Worcester Polytechnic Institute the hour plan is an annual affair because it depends to some extent upon the number of students and the consequent number of divisions in each class. This becomes a serious task to some of the instructors and adds to their burdens entirely outside of teaching.

Engineering schools are constantly receiving suggestions about improvements in their courses of study. I have just now on my desk at home either outlines or suggestions for new courses covering safety engineering, administrative engineering, business engineering, human engineering, aeronautical engineering, mental hygiene, and I do not know what to do with them. These propositions are symptomatic of the whole country where everybody has a happy thought which he is exploiting. Washington is infested with the happy thought people who are working out new plans. Our trouble is chiefly that we are not unlike the Bandarlog of Kipling's stories. We cannot in the ordinary engineering school add any new courses for we have not the space for them. We might substitute other courses in order to change the engineering program into one for business men. It seems obvious, however, that our first task is the education of young men in the fundamentals of applied science. While education ought to keep up with the times it would be a mistake to substitute for the ground work on which our profession rest, something that is merely technical and informational. No subject that has been found by long experience to be of value in developing the mind ought to be abandoned for a technical course in administration, business or aëronautics. Engineering education will gain nothing if we are led astray by the results of the war into professional courses which a man would naturally learn after graduation. Some universities and colleges have adopted in their engineering departments a straight three-year course in engineering with no specializing whatever, leaving the fourth and perhaps a fifth year for a large amount of professional work. If this can be done in such a way as to place the last years at the disposition of the department in which a young man is going to graduate the hour plan is simplified and the whole course of study is made systematic. It may be added here that a fifth year, especially if spent in another college or university would be excellent.

It has been suggested that the engineering schools ought to have a closer alliance with the engineering societies. I have written a report on that subject for the information of the

American Society of Mechanical Engineers in the hope that that society may take some share in the education of students for their profession. There are now about forty-eight student branches of the society in the United States. It is possible that our own society, the S. P. E. E., might help this relation by interesting itself in the student branches of all societies. Two points have been suggested. First, that certain scholarships should be offered to the engineering colleges having student branches, and second, that a definite program of work to be conducted by the students themselves might be planned out in a syllabus of some kind. At the present time most student branches or student societies break down because they do not have anything that really appeals to them for their weekly or monthly meetings. There is no use in a student society's attempting to repeat for the edification of its members what is given in the classroom. My belief is that some interesting subjects disconnected from the studies might be worked into a little handbook that would prove extremely valuable. I have ventured to suggest any one of the following for the coming year:

1. The general effect of the peace conference and the league of nations upon the work of the engineer, especially in commercial life of the nation during the next generation.

2. The method by which war disorganizes industries and the work of reconstruction that invariably follows every war. The general readjustment that must follow this war in all the belligerent countries.

3. Standardization for manufacture and the effect of this war in forcing engineers and manufacturers to reduce the number of parts and to simplify construction of all kinds of machines. Standardization for guns and munitions.

4. Conservation of national resources including fuel, water, soil, forest and minerals.

5. Labor and the complete readjustment of society in order that employer and employee may live together in peace. Ex-

amples of the solution of problems in different manufacturing companies.

6. The problems of transportation, national and private ownership, and the changes consequent upon improvements and rapidity of transportation.

A student branch may have a number of purposes so that the above is offered merely as a suggestion. I am listing here as a further suggestion the general purposes of student meetings.

1. To get outside lecturers on technical subjects.
2. To get outside lecturers on non-technical subjects.
3. To get salesmen or agents from manufacturers to describe their product, usually illustrating with a stereopticon.
4. To obtain lectures on general subjects from members of the general faculty with which the engineering department is connected.
5. To encourage students to speak on their feet in public meetings (*a*) by giving them the periodicals and books to be reviewed orally; (*b*) by having the results of these and investigations conducted by the student described; (*c*) by the delivery of brief addresses on non-technical subjects.
6. To broaden the contact with engineering by joint meetings with other branches of engineering in the student engineering society.
7. To bring students together, mainly for social purposes and for making them acquainted with associations and their usefulness to them personally.
8. To teach them initiative by non-interference with the student branches, thus leaving to students all activities outside of the classroom.

Just at this time we have a great deal of discussion in the United States on the subject of research. How far ought research to be encouraged in a technical school and in a university? The two types of institutions differ in this regard because the technical school rarely has the money to conduct research on a sufficient scale to make it of great value. Some of the professors and instructors have time to do something and it is to be hoped that legitimate and proper research may be encouraged. We all know, however, the sham that often is perpetrated in the name of research. Theses are usually worthless so far as the engineering world or applied science is concerned. Furthermore, we are in a fair way to go at research in much the same way as a housekeeper would go at sweeping up a room to find a pin that had been dropped. We cannot sweep up the whole universe and our science as it is to-day will be something different to-morrow. There is room for a much better organization for study and research by bringing colleges into relation with the National Academy or with the testing departments of the great industrial firms of the country. Let us never forget in this connection the danger which science may hold for the whole human race unless we approach it in a spirit of righteousness, with a determination that it shall never be used for the destruction of all that mankind has done up to this time.

Has experience in the Students' Army Training Corps taught us anything? We must remember the two types of colleges. Those that have nothing but what is known as a general education as the end in view and those that have training for some occupation in life. The effect of the experiment with the Army varied much with different colleges all over the country. In New England it was not very satisfactory with any kind of a college. In the Middle West it seems to have been acceptable. I do not share the views of many educators, because I do not believe that we learned anything of any great value to us about courses or administration during these few weeks of military control. The war conditions taught us a great deal but it was not because we were closely allied with the Army. It is possible that colleges with no professional aim were benefited in some way. Instruction, however, suffered as the course of study were seriously interfered with and the object for which studies were given were largely lost sight of. We had a case in Worcester where young men were sent away to the heavy artillery school from two colleges, those sent from the Worcester Polytechnic Institute having had a first-rate training in mechanical engineering and those sent from an academic college largely religious in character having had no training in engineering. This was absurd. The net result was on the whole a lesson against too much control by the Army and Navy.

If military training is to be continued it should be on terms offered by the engineering colleges and arranged in such a way as not to interfere with either administration or organization. If the specifications are supplied by the War Department in which the colleges have no voice there is certain to be the same kind of a result as that with the Students' Army Training Corps. The officers of the Army do not as a rule know much about education. Many of them have graduated from West Point which is a school of discipline—not an educational establishment—and consequently they usually err in making their plans too rigid. The summer vacation is the time for military training and under proper conditions six weeks every summer at a Plattsburg camp might be made one of the requirements for a degree. During the school year students should be under their regular faculty without any military control whatever and during the summer they could be under the discipline of the Army or Navy without any faculty control. Some additions or substitutions in the nature of physical training, military law, and the military policy of the United States might be advisable but it is doubtful if any technical training in materials for war would be worth while. Engineering schools are not unlike the professional schools of law and medicine where it would be poor business to place a military unit. Consequently any arrangement with the government ought to take into consideration the specialties for which technical schools train their students, specialties that are of the highest value in time of peace and of supreme value in time of war for manufacturing weapons and putting them into the hands of the soldiers.

I have made no attempt to go into great detail in this paper because I believe personality and character are far greater elements in the success of an engineering school than any type of administration. Our conception of man's life as one of orderly and steady development through the various schools so that a child may enter the primary department, subsequently the college, and lastly the career, without confusion, is not sound. Every one of these changes marks a sudden break and a necessary readjustment to new conditions. There is no system of instruction and no system of administration that will enable a student to glide smoothly from the secondary schools into the freshman year of college. He must get a jolt of some kind and must find himself under conditions approaching manhood where he is freed more or less from the tutelage of the home, of the boarding school or a high school. It is not necessarily a bad thing for a boy to have a break of this kind and it is rather a good thing that different colleges and preparatory schools should have their individuality. When we standardize education in such a way that all schools are alike and all teachers are alike, it will be nearly time to go back to the forest to live on nuts and berries. The chief interest in life is found in variation and no school ought to forget that.

We all know that organization depends for its effectiveness on men and women far more than on rules and constitutions. Yet some rules promote trouble and the chief effort towards college administration should be towards some system that minimizes the possibility of friction or lost motion and at the same time encourages the individual to exert his best effort. That is the only reason for administration of any kind. My conclusion is, that while the work of a college outside of the class room is interesting and while it should be well planned and carried out, the essential task is the education of boys and girls and the development of good, useful citizens capable of doing something. We have had too many examples of what administration and its unintelligent methods can do for a department in our own government. At times it seems almost impossible to do business either during peace or war. Certainly we have much to regret over the cast-iron system based on what is known as "passing the buck" and keeping minute records of things that have no importance. It was the most unsatisfactory performance of the war and but for the manhood and courage of our young soldiers overseas the scientific management in Washington would have lost the war. It is known as red tape and every government in the world is afflicted with it.

I can see only certain essential things of a definite nature to recommend in relation to the maintenance of a college, taking for granted that as much administration is put in as will carry the work without friction. They are:

1. The time of a teacher should be occupied with administration as little as possible.
2. The class-room work of a teacher should afford him leisure for improvement in presenting his subjects to students.
3. Students should be encouraged to present and discuss subjects for themselves, usually outside of the class room.
4. The national engineering societies should be asked to coöperate not only with this association but with the colleges themselves towards broadening out engineering education.
5. The salaries of professors and instructors should be sufficient.

THE PROBLEM METHOD AT THE ENGINEERING SCHOOL, U. S. ARMY, CAMP A. A. HUMPHREYS, VA.

BY MAJOR C. C. MORE AND CAPT. W. E. DUCKERING,
U. S. Army.

The primary purpose of The Engineering School at Camp A. A. Humphreys, Va., is to stimulate and encourage the student in the exercise of his power of independent thought, reasoning and judgment, and to increase his ability to cope with new situations when confronted with them in engineering practice, rather than merely to provide him with a fund of engineering information and abstract theory, valuable as the latter are as adjuncts in his training. This purpose was laid down as a guiding principle at the very beginning, by the Chief of Engineers, Major General W. M. Black, and was emphasized continually by Colonel V. P. Peterson, Commandant of The Engineer School. In the half-year ending June, 1919, under the personal direction of Colonel Earl North and with the enthusiastic coöperation of the instructors, this object was attained in the Department of Mechanics of Engineering, by the use of methods similar to those which have been in successful operation during the past six or seven years at the University of Washington, Seattle. (The Washington method of teaching mechanics is the outgrowth of several years of experimentation carried on with the enthusiastic encouragement and support of Professor A. H. Fuller, then dean of the College of Engineering. A brief description of this method is given in an article by W. E. Duckering, in *Engineering Education*, May, 1917.)

The major portion of the classroom work was devoted to stimulating mental effort on the part of the student, and to training him in practical methods of attacking, analyzing, and solving engineering problems, instead of being devoted to the usual methods which attempt to cover a set amount of text-book material, and center instruction around that purpose. The student was encouraged to use his own judgment and to make use of ideas which had grown out of his own previous experience. An endeavor was made to lay the foundation for future effort within the student himself, rather than in a text which he could carry under his arm. Every encouragement was offered to the development of what may be called the "engineering mind."

In this method there are two definite phases of the work: First, the phase in which study problems are used, and second, that in which drill or training problems are used. Study problems were designed for purpose of analysis rather than synthesis, with concrete engineering situations used as a basis. Where feasible, the objective ideas corresponding to technical terms used by engineers were presented by means of visits to actual engineering structures. In this manner the students were enabled to more easily visualize and understand the technical language of the engineer. For example, a bridge was visited before the first study problem was taken up. The names and functions of the various parts were discussed, and the question was raised as to the path traversed by a load placed upon the bridge, as it is transmitted through the members of the bridge, from its point of application to the ground. This introduced one of the fundamental principles of engineering thought into the minds of the students at an early stage in their training. This visit to the bridge was not made for the purpose of analyzing that particular structure but to introduce the subject of structures in general. The subsequent class-room work dealt with a different type of bridge and during the course many types of bridges were used in problems, so that the student would not be limited, in his idea of bridges in general, by the one that he happened to inspect first.

In the classroom, the first definite study problem dealt with a pony-truss span, for which were furnished the usual engineering detail drawings showing all dimensions and sections. Military necessity required that a certain heavy howitzer be taken across the bridge. The question was asked: "Is the bridge, in its present condition, safe for this load?" With the situation before them, the students were turned loose upon the analysis of the problem. The next step, following naturally from the discussion held at the bridge site when inspecting the structure in the field, was to determine how the structure might fail. Each student was required to use his own ideas and make a list of possible sources of failure. These lists were taken up for general discussion, and from this as a starting point the students were led step by step to investigate the various members of the structure. The necessary theoretical analysis was introduced whenever required. The hanger and both chords had purposely been designed too light, thus adding an element of interest to the search for possibilities of failure. When the students discovered these members to be unsafe, they were asked to redesign them in accordance with standard specifications. Naturally, some phases of the analysis seemed too intricate for immediate treatment in the class; but these were easily deferred. For instance, in the case of the floor system, the investigation was carried to the point where the worst positions of the load were decided upon, and sketches were made showing the probable manner in which the planks, stringers and floor beams would break, but the determination of the actual fiber-stresses in these members was deferred temporarily with the understanding that it would be gone into carefully in subsequent discussions. However, the class was led to make recommendations concerning means of strengthening these parts of the bridge in case they were found to be unsafe.

At every step in the analysis of study problems, the many possible assumptions underlying the mathematical computations were always discussed at length by the class, and often two or more assumptions were taken as a basis for mathematical analysis before the students were encouraged to make final judgment concerning what appeared to be in line with the best practice. In this manner the student is made to realize that engineering is not an exact science, and the element of judgment plays a very important part in all engineering problems. He also starts his career with a more open mind and a greater capacity for making advances along new lines of engineering thought. He develops a keen interest in engineering literature, especially current engineering periodicals and papers and discussions of engineering societies. Students are not subject to the limitations of a single text, but find it advantageous to refer to several. An inevitable result of this kind of training is the tendency of the student to rely more and more on his own judgment with respect to making assumptions, and in all his work the student shows a greater self-reliance and an increasing desire to do independent thinking.

The chief purpose of the drill problems are to furnish vehicles for training, and for fixing the use and understanding of the fundamental principles firmly in the mind of the student by well-directed repetition. Practically all review work had these purposes in view, though it was possible to use these problems as a means of grading the students and of giving them their section rating. The purpose of these problems, held before the mind of the student, is the opportunity to set up good habits of analysis and work, and to increase by means of carefully organized and well executed computations and sketches, his power to get accurate results and develop speed, while at the same time each problem makes him more at home in the use of the necessary mathematics and mechanics. In order to aid in the accomplishment of these purposes, the major problems were broken up into a large number of subproblems so that the arithmetic might be made easy and so that particular attention might be directed to a great variety of special uses of the fundamental principles. In order that the student would know how to organize his work with a view to the development of speed and accuracy in execution, and as an aid to clearness of thought, he was required to work in accordance with a definite set of specifications covering the means whereby system, clearness, and accuracy may be attained. He was taught to recognize the importance of each step in the solution, as a link in the chain leading to a final result, and to surround his computations with as many safeguards and checks as necessity and time permitted. The result of this training in the mechanical side of analysis, was to increase tremendously the accuracy of the work. The student found himself not only getting more definite results but he also developed the power to find and correct his own errors. All this tended to increase his pride in his work and to give him confidence in himself; while at the same time he was forming good habits of thought and work which could be transferred to his engineering practice later on. In short, the class-room work was made to approximate actual engineering experience as closely as possible.

The results obtained make it clear that a system of instruction designed along the lines sketched above, does decidedly awaken and hold the interest of the student in the live problems of the engineering world. It does increase the confidence with which the student tackles a problem and stimulates his self-reliance and initiative, and at the same time he shows greatly increased industry and speed of learning. This is further accentuated by the fact that no grading is done on study problem work. The student is left free to take chances in doing independent thinking. The grading for purposes of classification in sections is based entirely upon work done on drill problems. The student is given to understand, however, that the only grades which effect his final passing in the course are those determined in the last four or five weeks of work, when nothing but review problems are taken up. His desire to work for passing marks becomes secondary and is dwarfed by his desire to understand engineering theory in order that he can use it in his work. His career as an engineer has begun.

This method of teaching mechanics offers unusual opportunities for instructors to do original work, by bringing in new problems derived from their own experience, and by making improvements in the methods of presentation and instruction. During the course at The Engineer School the class-room instructors suggested and worked out several study problems of great value and they also discovered certain new applications of theory which greatly amplified the work in some parts of the subject, and extended the usefulness of certain laws. The following officers were class-room instructors and to them is due great credit for the success of the course; Majors O. O. Kuentz and H. W. Sibert, and Captains L. Graham, W. E. Duckering, W. A. Lyon, E. R. Hyde and G. M. Steese.

EDITORIAL.

College Administration.—Seldom has there appeared a better presentation of the different phases of college administration, than the article by President Hollis of Worcester Polytecrnic Institute, appearing in this number of ENGINEERING EDUCATION.

The object of administration in colleges should be to assist the teachers. There is no other excuse for an administrative organization. If the administration requires the teacher to take an undue amount of time from his teaching duties to make reports, attend committee meetings, needless faculty meetings, etc., then the administration fails to accomplish its object. It is unfortunate that the trustees of many institutions come in contact only with the problems of administration with the result that the administration seems to be the institution. Many have the point of view of the trustee who happened to meet the editor in the office of the superintendent of buildings, and in the course of conversation said that this office, *i. e.,* the superintendent's office, was the most important one in the institution, showing that he failed to comprehend the reason for the existence of such an office which is simply to provide proper space for teaching. A multiplication of records and reports absorbs the time and the energy of the teacher which should be devoted to the preparation of his work of teaching and research. The administration should be so simple and flexible that the teacher does not know that it exists. If, under such an organization, certain men fail to function properly, it demonstrates the fact that they are not the proper type of men for teachers.

Often in the discussion of college administration the idea is conveyed either directly or indirectly, that administration is one factor and teaching another. As an actual fact we know that the two are one and the same. Administration can not be separated from teaching. Probably in no other organization does such a separation occur. It is, perhaps, unfortunate that the word administration, has come into such universal use in connection with college organization.

AIMS OF ENGINEERING SCHOOLS.*

The controlling consideration in the selection of the teaching staff and in the planning of the instruction in the new Harvard Engineering School are thus stated by President A. Lawrence Lowell: "To train men to think; to lay a broad and deep foundation with a superstructure which can be completed only gradually from the training and observation that come from practical experience; to encourage the student to understand each problem so thoroughly that he can apply the same principles intelligently in the solution of different kinds of problems; and, finally, to train men to be good citizens as well as good engineers." President Lowell has expressed in a few words the principles that are probably subscribed to in theory by all engineering teachers, but which, on an impartial study, many of them would have to admit had been violated in the planning and conduct of engineering courses. What we have been trying to do in discussions of engineering education lately is not so much to discover new principles as to prove again to ourselves the validity of old principles, and to inquire whether the methods we have been pursuing square with what is sound in theory. President Lowell's declaration is a good one. We find the same principles widely subscribed to. We hope, however, that all who accept them in theory will remember the homely phrase that "the proof of the pudding lies in the eating thereof." Do engineering courses produce the results that President Lowell lays down as the purpose of the new engineering school?

---

* *Engineering News-Record,* Vol. 83, No. 9, p. 397.

LETTER TO THE EDITOR.

It certainly sounds like a noble thing for a professor to aspire to teach his pupils to think and to do research work and to accomplish something beyond the mere acquisition of information. Articles written with such ideas in mind and proposing to teach students to invent and originate, read very beautifully. I feel, however, that such articles are only visionary and that the writers have their heads in the clouds.

An almost negligible percentage of pupils have power to invent and do original research work. This power cannot be given by any amount of instruction. If courses are therefore planned with the idea of developing such powers, they will only suit an exceedingly small percentage of the pupils. It is very often the case that the majority of the pupils in the class are in a haze as to what the instructor with such ideals is talking about.

If any engineering instructor will take a census as to what his pupils are doing five or ten years after graduation, he will find very, very few doing original research work, and a very large majority using detailed information of various kinds which they have to grope for in engineering handbooks and the like, because they were not given concrete details during their college course. The very few pupils who are fitted to do research work and think independently have no need of any special training in this direction. They can profit greatly by the same sort of course as is given their less original classmates. They themselves have the necessary power to add to such a course, whatever is necessary.

Sanford A. Moss.

May 6, 1919.

COLLEGE NOTES.

Colorado School of Mines.—Professor A. P. Little, formerly of the Bureau of Standards, who has been at Yale during the past year in connection with the Signal Corps Training School for Officer Candidates has been appointed professor of electrical engineering.

University of Kansas.—C. M. Young has resigned from the position of assistant professor mining research at the University of Illinois to take that of professor and head of the department of mining engineering at the University of Kansas.

Lehigh University.—Ralph J. Fogg, a member of the civil engineering department for eleven years, has been appointed professor of civil engineering and head of the department, and Dr. Fred V. Larkin, for the past four years assistant superintendent of the Harrisburgh Pipe and Pipe Bending Company, has been appointed professor of mechanical enginering and head of the department.

Massachusetts Institute of Technology.—Dr. V. Bush has been appointed associate professor of electrical engineering. Dr. Bush is a graduate of the Electrical Engineering Course of Tufts College and received an M.S. degree from that college in 1914. He received the degree of doctor of engineering from the Massachusetts Institute of Technology in 1918.

Messrs. Frederick S. Dellenbaugh, Columbia University, 1910; Arthur L. Nelson, Massachusetts Institute of Technology, 1915; and F. B. Philbrick, Massachusetts Institute of Technology, 1918, have been appointed instructors in electrical engineering.

Sheffield Scientific School of Yale University.—L. W. W. Morrow, who has been at Yale on leave of absence from the University of Oklahoma during the past year, is retained at Yale as assistant professor of electrical engineering.

G. F. Wittig has been made assistant professor of electrical engineering in the Sheffield Scientific School. He has been at Yale during the past year, first in connection with the Signal Corps Training School for Officer Candidates and after its disbanding has been a member of the physics department.

H. M. Turner has been made assistant professor of electrical engineering in the Sheffield Scientific School.

The University of Minnesota.—The board of regents of the University of Minnesota voted that Dean Lauder W. Jones, who is at present dean of the School of Chemistry, should also fill the position of dean of the College of Engineering and Architecture. They have in mind the correlation of the work of these two colleges and hope at some future time to combine with them the School of Mines and make at this university an Institute of Technology. Dean Jones assumed his duties July 15.

BOOK REVIEW.

The Civil Engineer's Pocket-Book. By JOHN C. TRAUTWINE, Civil Engineer. Revised by JOHN C. TRAUTWINE, JR., and JOHN C. TRAUTWINE, 3D, Civil Engineers. Twentieth edition. xxxii + 1,528 pages. Trautwine Company, Philadelphia. Price $6.00.

This, the twentieth edition of this famous handbook, is a worthy successor of the previous volumes. Three hundred and twenty pages of new matter have been added and much of the former material has been condensed and arranged in a better manner.

The chief addition is the large section devoted to railroad construction and maintenance. This presents in handbook form all the facts than an engineer will need in this work.

The physical appearance of the book is good, the typography clear and the thumb index furnishes a ready means of quick reference.

BULLETIN

OF THE

Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee:

Arthur M. Greene, Jr., John F. Hayford, F. L. Bishop, *Editor.*

Address all communications to the Editor, University of Pittsburgh, Pittsburgh, Pa.

VOL. X LANCASTER, PA., NOVEMBER, 1919 NO. 3

TABLE OF CONTENTS.

The Purpose of Engineering Schools. Frank J. Goodnow........ 81
Industrial Research—Its Function and Administration. R. E. Carpenter 91
Some Remarks on Coöperative Method of Engineering Education. V. Karapetoff 101
The Unconscious Plagiarist. G. I. Mitchell 105
Representatives of the Society at the Different Institutions 107
Editorial 111
College Notes 113
The National Committee on Mathematical Requirements 114

THE PURPOSE OF ENGINEERING SCHOOLS.

BY FRANK J. GOODNOW,

The Johns Hopkins University.

It gives me great pleasure to avail myself of the privilege which is mine as representing the Johns Hopkins University to welcome the members of the Society for the Promotion of

Engineering Education at their meeting on this occasion. The university esteems it an honor that you have accepted our invitation to carry on your deliberations within our halls. Our feeling of gratification is due to two considerations. In the first place we feel pleased that you are here. In the second place we congratulate ourselves that, although we have perhaps the youngest engineering school in the country, you have been willing to welcome this infant, so to speak, among the ranks of mature men. We feel sure that we shall profit greatly as we listen to the words which you will utter, based as they will be, on your long experience in the field which we all are cultivating.

I feel, however, that my words of welcome should be accompanied by an apology, perhaps, I should say apologies. For as I see it two apologies are due. One, an institutional apology. The other, a personal apology.

I have referred to the youth of our engineering school. Now youth, whatever may be the advantages, which are its incident, is subject to certain disadvantages. Our institutional youthfulness consists not merely in the recent establishment of our school but as well in the fact that the university, of which the school is a part, has been located at its present site for only a very short time. We have had neither the time nor unfortunately the money necessary to put our physical environment into a condition which permits us to offer to you the kind of hospitality which you deserve. We have no dormitories in which we can give you accommodation nor a commons in which the material wants of the inner man can be satisfied. We must perforce ask you to make a somewhat long journey from your hotels to Homewood, and to pick up a hasty lunch in the midst of the machinery with which your work days are perhaps too familiar.

When I think of what we can offer you I am somewhat amazed at our audacity in inviting you to hold your meeting here. I fear indeed that had you known our conditions you would have hesitated somewhat before consenting to come.

But we are glad to have you with us and I hope that your meeting will be successful, profitable, and interesting.

I have said I owed you a personal as well as an institutional apology. That apology is due for what I am going to say apart from these few words of welcome. It has been my fate to be president of an institution which pays comparatively little attention to those branches of study with which my past work has made me familiar. A lawyer I have been for the past five years, connected with an institution which has no law school. With little, if any knowledge, of science or the mechanical arts I have been obliged to concern myself with questions to whose solution I have been able to contribute but little. You can well imagine that during the past five years I have had to submit myself to a process of education.

So when it becomes my privilege to address the Society for the Promotion of Engineering Education, and when I realize that I am venturing to say something on the subject which specially concerns that society I am reminded of a story I heard the other day of a university president who had been long in the harness and who knew pretty well what was to be expected at such functions as university presidential inaugurations. He was in a train en route for one of these ceremonies when a friend saw him and asked him where he was going. His reply was "Oh, I am going to hear some first thoughts on education." When I recall that story I am conscious of the fact that I am taking perhaps an unjustifiable advantage of you in asking you to listen to some first thoughts on engineering education.

My only excuse for making this demand of you is that largely because of our recent experiences educational waters generally are stirring and I feel sure that the waters of engineering education are no exception to the rule.

Some of the first thoughts on this subject which have come to me, really a layman, are in the nature of queries rather than conclusions.

The most important as it seems to me is the query:

What is the purpose of an engineering school? Perhaps the query should not be framed this way. For it may well be that there is no such thing or should be no such thing as a typical engineering school. Perhaps there are and should be different types of these schools. If this is the case, then I suppose the query should be, what is the purpose of the particular school with which we happen to be connected? This query it seems to me we must answer before we can reach any really valuable conclusions as to the character of the engineering education which we should endeavor to provide.

As I have come to see it, engineering schools in general or any particular school may have one of three purposes. Perhaps, while any particular school may emphasize one of these purposes it may have the other purposes as well in mind.

Now these purposes as they outline themselves to one who comes without any experience and with very little knowledge to consider these problems are: (1) General education with emphasis laid on scientific subjects; (2) professional training; and (3) engineering research.

Some schools which I imagine may be classed as engineering schools started as scientific schools, *i.e.*, schools in which it was sought to give a general education through the study of subjects scientific rather than literary in character. Many schools which when organized were schools for the cultivation of mechanic arts have become schools devoted to general education with emphasis laid on the sciences and giving little if any attention to classical studies. There is further, little doubt that many of the graduates of engineering schools do not as a matter of fact make engineering in any of its branches their profession, while it is also true, I believe, that some eminent engineers never had an academic engineering training but went from a so-called literary college into the practical work of the engineering profession.

Now, if the purpose of engineering education, or perhaps I should say if the purpose of an engineering school is to give its students a general education which will be of benefit to them in other than the clearly professional ranks of life the problems which present themselves are very similar to those presented in the ordinary college. They are not exclusively intellectual but are as well moral problems. What must be sought is in some way to foster the building up of character, the cultivation of industry, particularly intellectual honesty, the capacity to evaluate correctly the things which life presents and the ability to make a profitable use of one's leisure time. If the scheme is to be successful these qualities must be developed in addition to the acquisition of any particular facility or any particular kind of information.

If, however, the primary purpose of the school is professional training I imagine few of us would be willing to say that a by-product, at least, of the school should not consist of the qualities which I have mentioned. I have used the word by-product because I feel that no set of subjects of instruction can claim a monopoly in the production of these qualities. Some of them will be the result of the community life which the students live. Some will be due to the personal influence of the instructor. For few, if any, will the subjects studied be solely responsible.

But assuming that the qualities which should be the result of all education are secured, a scheme of education which emphasizes professional training as its principal purpose, must seek for something more. What that something more should be is a question which I hesitate to attempt to answer. I am afraid my first thoughts are not sufficiently definite or not sufficiently based on experience to have any great value. I can only make a few hesitating suggestions based on experience in other fields. There is always great danger in any line of work that instruction in it becomes entirely academic. The instructor is always apt, particularly if his life is encompassed by the barriers of institutional environment, to get out of touch with actual life. He comes to live in a world of his own and of his immediate fellows which is quite different from the extra institutional world. In some lines of work such an attitude of mind may not be accompanied by serious disadvantages but a professional school whose instructors are of this character tends to become too theoretical. Its instruction easily becomes too didactic. Its learning becomes almost purely book learning. Its graduates find when they enter real life that they have much both to learn and unlearn. I imagine the history of engineering education will show not a few instances of this tendency towards the academic and away from the actual. Certainly this has been true of many of our agricultural colleges. I remember one case decided by one of our state courts which is illustrative. An action had been brought to take away a charter from an agricultural college because of the fact that it was using for classical instruction money given for the teaching of agriculture. The court refused—courts are always reluctant to forfeit charters—to take away the charter alleging as the reason for its action that a knowledge of Latin and Greek would assist the would-be agriculturalist to understand agricultural terms.

The same problem confronting engineering schools which emphasize professional training as their primary purposes, has also confronted the professional schools of law and medicine. Thirty years ago instruction in these schools was almost entirely didactic. In the law schools the student studied text-books and attended formal lectures. He seldom read a case. In medicine conditions were almost the same. The student read about typhoid fever and pneumonia in a book or heard them described in a lecture. He seldom, if ever, saw in his course of study an actual case of a person afflicted with these diseases. He certainly never participated in the care of patients. This has in large measure been changed. Law students read and discuss actual reported cases as a part of their regular course of instruction. Medical students receive what is called bedside instruction in hospitals attached to the schools they attend.

The problem of the professional engineering school must be solved in somewhat the same way. Laboratories may help but they will not be sufficient. For laboratory equipment soon gets out of date and with the resources at the command of most schools may not be scrapped and replaced by something new. The engineering schools will have to devise some contact with the outside world which will make their instruction real and prevent it from becoming merely academic. But that contact must be such that neither the instructor nor the student gives up more of his time to purely routine operations and processes than is necessary to acquaint him with the conditions of the world he is to enter.

Finally, even in a school which emphasizes professional training something must be done for the student which will help him in his life outside of his profession. For he is a man and a citizen as well as an engineer. As a man he must live a life which has many other than professional contacts. He will be in a world which has other than professional interests. To get the greatest profit from that world and to lead a life which is most worth while he must some time during the period of his education lay the basis for the cultivation of tastes which will enable him to enjoy non-professional things. As a citizen he must participate in the solution of problems which democracies must solve. It is true that the cobbler must stick to his last but when cobblers are called as they are in popular governments to take a share in the determination of policies they must in some way be assisted to reach right conclusions. What is true of cobblers is even more true of engineers. For engineering may be regarded as a learned profession and engineers are educated men, who may properly be called upon to share the leadership which is so necessary to wise political action. I heard the other day of a student in the Students' Army Training Corps in one of our leading universities who was asked in an examination the name of the people who inhabitated Hungary. His answer was the "McGuires." While that answer revealed the fact that the man had a basis of historical and political knowledge, yet that knowledge was so limited and imperfect that it might lead to the conclusion that he had mistaken Hibernia for Hungary.

I would not be understood as asking that the engineering student should be expected to acquire an extensive historical knowledge during his undergraduate course. With the demands made upon him by his strictly professional subjects such an expectation would be doomed to disappointment. But after all there is no reason why engineers should not be reasonably cultivated men. And for the average man the foundation for such cultivation as he is successful in acquiring must be laid in his college course.

One of the difficulties which will be encountered by those who try to lay this foundation is the reluctance which the average engineering student has to devote himself to these non-professional courses. He regards them both as useless and uninteresting. Perhaps a large measure of blame for his attitude must be laid on his instructors. Perhaps if a greater attempt were made to make these courses attractive even at the peril of having them regarded by the student as "cinch" courses greater success would attend our endeavors to coax the engineering student to consider of value the non-professional work which in his own interest he should be required to undertake.

The two problems which would appear to be as yet unsolved in the schools which emphasize professional training are thus the contact with the outside world of engineering and the cultivation of the man and citizen as well as the engineer.

The third purpose which engineering schools in general or some engineering school in particular may emphasize is engineering research. This purpose is probably the most difficult of realization. Research in pure science may without great difficulty be carried on within academic walls. It, of course, involves the expenditure of large sums of money needed for the equipment of laboratories and for the staff to which the investigation of problems is intrusted, but experience has shown that carrying on such research is not beyond the powers of educational institutions. When, however, we come to the applications of science conditions along many lines are quite different. The laboratory methods which suffice for pure scientific research are often ill adapted for the work which must be done. For the purpose of much engineering research is not so much the ascertainment of scientific truth as it is the determination of the commercial practicability of particular methods of quantity production. This purpose can hardly be realized in many cases in any laboratory which a university may be expected to provide. Engineering research must in many cases, to be successfully prosecuted, be carried on in the factory and in the mill.

There are, however, unquestionably many problems the solution of which can be begun in an engineering laboratory. There are probably some the solution of which may be completed there. So far as this is true it is very desirable that an engineering school should, if possible, devote some of its attention to their solution. For the student who thus learns to solve problems not only acquires knowledge about his profession but at the same time cultivates a mental attitude the possession of which will probably be of greater value to him than the mere acquisition of knowledge. Work of this character is even more valuable to the instructor than to the student. Successful accomplishment in this direction at the same time stimulates his imagination and makes him a more inspiring teacher. No one who has devoted many years to teaching can fail to notice the deadening influence upon his work of a persistent and continuous attention to what is known unaccompanied by some striving on his part to apply what he knows to the discovery of something that is unknown.

It may well be, therefore, that the most successful engineering schools will be ones which endeavor on the one hand to use the subjects which they are called upon to teach as subjects from which some measure of general education can be obtained and on the other to give a reasonably adequate professional training with which will be combined some attention to research. But it can hardly be expected that any school can hope successfully to do much more than to lay the foundations upon which the student must subsequently build. No engineering school, any more than a college, can expect its students to acquire all that is comprised in a general education. No engineering school, even if it devoted itself exclusively to professional training, could hope to turn out its graduates finished engineers. Nor could it if it gave all its time to engineering research hope to solve all the problems which arise in industry.

So it seems to me that the problem at the basis of engineering education is essentially the one lying at the foundation of all education, which can be carried on in an institution more or less academic in character. This is the combination of fundamentals, a reasonable breadth of view and the cultivation of the capacity to solve the new questions which are continuously presenting themselves in every line of work. Such are some of the first thoughts on engineering education which one not a member of the guild ventures to present for your consideration today.

INDUSTRIAL RESEARCH—ITS FUNCTION AND ADMINISTRATION.*

R. E. CARPENTER,

Manager of Lynite Laboratories of the Aluminum Castings Company,
Cleveland, O.

While a great deal has been said of late in various technical publications regarding research work and the organization of industrial research laboratories, I believe there is still opportunity for the advancement of the idea, since not only does the manufacturer or proprietor shy at the word "research," but he is more or less aided and abetted in this tendency by a certain percentage of the engineering fraternity. I believe certain mechanical engineers are a bit too prone to consider their textbooks the last word and to place too little value upon advanced scientific developments which are being made from day to day not only in our college laboratories but in the industrial laboratories that are becoming more and more general throughout the manufacturing world. The fact is that a large amount of valuable research work which is being carried on today is of an absolutely non-sensational order and in many cases, being of a confidential character, it therefore does not get into the limelight of publicity through the technical literature. The fact that such data are not available in the literature until it has served to advantage those producing it, I believe to be one of the best arguments in favor of industrial research work. Each individual concern must carry along its own scientific developments if it is to stay abreast with the times. Many important scientific developments are first brought to light in the form of a finished product ready for the market, perhaps a considerable time after the scientific phases of the work have been written into history, which history, however, is for the particular benefit of the concern financing the work. Some of the most profitable and beneficial lines of research have to do with the stopping of the leaks that are bound to occur in concerns whose business is expanding rapidly, particularly those utilizing or producing raw products.

---

* Read at the Mid-West Sections Meeting, A.S.M.E., Indianapolis, Md., October 25, 1919.

Writers on the subject of industrial research have used as an example the development of the tungsten filament, which happens to be one of the sensational products of research, until this illustration is practically worn threadbare. However, the most pessimistic cannot but admit that the old saying, "Where there is so much smoke there must be some fire," holds true with respect to the awakened interest now evidenced in industrial research throughout the country. In my remarks on this subject, I shall endeavor to deal more particularly with some of the fundamental functions of research to industry and the principles involved in the administration of research affairs and bring out as clearly as possible those phases of the work that are analogous to any well-organized industrial activity. The coördination of research and development departments with those of production and sales is as important as the coördination of the actual activities of the research and development organization itself.

In spite of the fact that the word "research" is one with which the industrial world is becoming more and more familiar, I believe in the minds of many manufacturers it is still shrouded with considerable mystery and hazy misconception. When the word is spoken, some of us have a mental picture of the proverbial absentminded college professor surrounded by a disorderly array of miscellaneous apparatus, delving into abstruse phases of some given art or science in the hope that he may hit upon some new law, force or element with which to startle the world, but we do not associate him as a benefactor of our everyday life. Let us forget this picture and define the word "research" in a more up-to-date manner.

INDUSTRIAL RESEARCH.

The dictionary says "research is a systematic investigation of some phenomenon or series of phenomena by the experimental method to discover facts or coördinate them as laws." To tie this definition down to industry a bit more definitely, I would say that the object of industrial research is the establishment of improved standards by acquiring and compiling technical data of which fundamental facts are the basis.

The necessity of acquiring reliable technical information and facts concerning any given art is today coincident with the development of any large manufacturing establishment, provided such establishment is laying broad plans for the future.

A great deal of valuable work has been done in past years under the guise of engineering development which might basically be called research work, but the term was not at that time as popular as it has become today. I refer particularly to the utilization of by-products which has been carried out to a remarkable extent by various large industries throughout the country.

Dr. Meese has quite properly stated that the smaller the concern the more urgent the necessity for research work. There is hardly a concern today dealing with manufacturing processes that cannot afford to spend a certain portion of its income in studying the purely scientific phases of its product. Industrial development and advancement must be based upon standards and the establishment and maintenance of these standards is of vital importance to the growing concern.

The numerous process troubles which are encountered in the manufacture of practically everything we use today are the first manifestations of the necessity of these standards and as a business becomes more complex, these troubles become more and more numerous and the necessity for analyzing them and ascertaining the facts back of them necessitates the application to the problem of minds trained in the various sciences involved. Pure scientific research may be shared by both the college and industrial laboratories, but applied science must be fostered by industry alone. It is as important to know what not to do as to know what to do, as a great deal of time and money is often spent in doing the wrong thing over and over in various ways before the right way is found, more or less by accident.

As an example of one of these works problems that caused one of our largest industries a great deal of trouble for many years, I would cite the instance of the effect of changing humidity on the spinning and weaving of cotton. About twenty years ago this problem was studied by ventilating engineers and a method of atomizing moisture into the atmosphere of the spinning and weaving rooms of cotton mills was developed so that a close control of the humidity could be maintained and the tendency of the ends to break because the weather changed over night from humid to dry or to slacken up and necessitate considerable readjustment if weather conditions were the reverse, was obviated.

While the need of research in industry is first felt by the necessity of applying science to solving fundamental problems of production, the research department, if properly manned and backed up does not long assume the rôle of the doctor prescribing to the ailments of business but by reason of the knowledge and experience thus gained soon assumes the rôle of pilot laying the course of the ship of industry through safe channels along the rugged shore of experiment and development to the ports of profit and success.

In the administration of industrial research affairs, an important phase is the coördination of the different types of minds one encounters in a manufacturing establishment, all of which can further or retard the work, depending upon their attitude toward the proposition. Another and very important phase is the selection of tasks or problems. Usually these will be presented in large numbers and will have to be weeded out by preliminary consideration. I strongly recommend the clear definition of each general problem and its details; the very definite recording of its object and the establishment of a budget system requiring separate appropriations for each problem which may have to be increased from time to time if the problem takes on a more elaborate character of investigation than at first anticipated.

Space, facilities, and apparatus are never ample from the viewpoint of the research worker, but these should nevertheless be provided without stint if good and quick work is to be expected. The mistake is often made of hiring a good man and limiting his usefulness by inadequate facilities with which to perform his task.

I cannot entirely agree with the fifth conclusion in Dr. Frank B. Jewett's paper read before the Royal Canadian Institute at Toronto, September 8, 1918, and recently quoted in *Mechanical Engineering,* in which he states that, "Whatever the scheme finally adopted to provide for an expansion in the domain of fundamental research and the development of competent industrial workers, care must be taken to insure that pressure from the industries will never be so great as to withdraw those men who can render the greatest service by continuing as investigators in the field of pure research and the training of younger men."

He goes on to say that "Such a course would be suicidal if long continued and I mention the point because of the fact that my experience indicates a considerable tendency on the part of industries which have benefited from industrial research to endeavor to attract into their service the best of the university research men."

Dr. Jewett's conclusions may in part be true, but I certainly feel that such conclusions may be properly considered to include simply men of strong individualistic tendencies who would with considerable difficulty conform to the requirements of organization work or who, by reason of their own desires, would prefer the sanctity of the university laboratory to the opportunities presented in well organized and financed industrial research work along some specific line.

On the other hand, I feel that it is entirely legitimate and necessary for industrial institutions to search out men of genius and promise, even though they may be filling important places on the faculties of educational institutions and give them the opportunity to further broaden their horizon in assisting to organize and conduct industrial research where they have the opportunity to take the young college graduate crammed with theoretical textbook knowledge and assist in the great work of educating him in the application of these theories to the everyday problems of some specific industry.

We must not overlook this very definite need for breadth of vision and mature judgment in the training of the rank and file of industrial research workers and I maintain that our educational institutions must share such talent with the industries in order to carry this work to its end at maximum efficiency and speed.

Let us dwell for a moment on the industrial research organization from a personnel standpoint. Let us assume, for example, that a certain industrial establishment already has an engineering department and is producing a product that requires mechanical engineering talent, not only in its design but in its production. Let us also assume that the pressure of competition as well as the necessity for broadening and extending its field of usefulness has so impressed the executive head of the business that he feels the necessity for a more scientific understanding of the materials and processes that enter into his product than his present organization can supply, which understanding in turn may assist in a still broader application of his product to the market as well as the possible greater utilization of by-products. He therefore decides to organize a research department capable of covering all three of these phases of his business in a thorough and scientific manner. His first step should be to select from his own organization, if possible, some one in complete sympathy with the ideas and of sufficient breadth of vision and experience to appreciate the point of view of the scientist as well as the engineer; with some knowledge of his business problems and a general knowledge of business affairs. It is vitally important in the early days of a research department of any business that someone who has a keen appreciation of the point of view of the board of directors, and the production and engineering department as well as that of the scientific worker should act as the intermediary between these various divisions of the organization, as any one endeavoring to introduce research into an established and going business will find a tremendous lack of sympathy on the part of the production organization for the mental attitude of the research worker. Respect for and confidence in the new department can only be built up by the tactful education of all factions which must positively be properly coördinated if the work is to be a success.

This is a difficult position to fill, but it is vitally important. In a small concern the president or general manager is the logical person to function in this position, but in a large concern of extended affairs a separate individual is necessary and should be responsible directly to the president. This individual must, also, have sales ability, since on the one hand he must continually sell the proposition of research to the production organization and on the other hand sell the needs of production and sales to the research organization. He must furthermore assume responsibility for administering all of the routine affairs of the department so as to relieve the scientific director himself of all annoying details so that his whole thought and time can be devoted to the direction of the scientific phases of the work. In some of the large industrial laboratories that have been established for a number of years we find the scientific director carrying this function on his own shoulders, but it is usually found that such directors have had some considerable experience in and knowledge of general manufacturing processes in the specific art involved and have had the sympathetic coöperation of some principal of influence in the organization to help them over their early trials. It is, however, extremely difficult to find the combination of qualification necessary to function in both capacities in one man.

We will now consider the scientific director himself. He should be a man, preferably of some standing and experience in the particular science most involved in the company's product, well balanced in his ideas, strong of character and yet not individualistic with ability and experience as an educator. He must necessarily embody a keen understanding of human nature, and be as young a man as can be found that will answer the requirements, as very often several years are required for him to gain a thorough knowledge of the practical traditions of the particular product which he is to consider from a scientific standpoint. Such a man should ultimately become a powerful factor in stabilizing and building the business. The director's first duty will be to carefully study the company's product and production problems. He must qualify himself as an authority on all of the technical phases of the business and while he himself may do but very little of the scientific work, he must be able to direct same and judge results. His second task is the selection of his scientific staff and his ability to do this well will in a large measure spell his success and that of the department. A specialist in each branch of science involved in the company's business should be secured and he should be allowed in turn to secure his assistants.

Supporting this scientific staff should be provided various service features, such as a staff for library work, the compiling of bibliographies and the abstracting of articles from technical publications. A close liaison should be maintained with sales, production and patent departments by one or more individuals with scientific, engineering, or practical experience as the case may require. I believe that it is often highly desirable to mix with scientific men a number of engineers and practical specialists, particularly if the work of the Research Department combines any phase of experimental development.

The most important phase of the first two years work of an industrial research department is the development of men. Therefore, select young men with potentialities whose training and enthusiasm will provide a ground work for the development of concerted team work rather than brilliant individual attainment.

To vitalize the immediate future of industrial research, we, first individually, and second collectively as a great engineering society, have a real work to perform which might well be considered a duty. We passed some time since from that period of industrial development in this country marked by the slaughter of natural resources which lay in such abundance that huge industries were built up without any considerable regard for the economic and complete utilization of nature's stocks. For several years far-sighted men have been preaching the doctrine of conservation of natural resources. One phase of such conversation is the more complete utilization of what we are obliged to consume. This means scientific research, not only in the iron and steel industry, the paper industry, the packing industry, the electrical industry, all of which have well-advanced research departments at the present time, which incidentally, is one of the reasons for their size and impregnable position, but scientific research in every industrial activity of the nation. Every last thread of our national industrial fabric must necessarily pass under the microscope of science if it expects to survive. Every ramification of our business structure must do its share of writing the textbooks of the future. That is all that research is—simply using the scientific knowledge of today to write the science for tomorrow, but since this must needs be checked and verified, as we go along, we use the industries upon which depend our very existence as the vehicle for its propagation.

The introduction of science into industry serves a double purpose. By reducing cost and at the same time improving product, it automatically raises the whole standard of manufacturing products, thereby stimulating national competition which will, in turn, help us to stem the tide of international competition. The necessity of intensive utilization of space and resources has awakened Europe to the importance of research until it is far ahead of us today in this respect. We must study this situation at first and profiting by what has thus far been accomplished in Europe, so organize our industrial research that we may assume an offensive rather than a defensive position in the markets of the world. If we can but convince one or more prominent concerns in each industry that the application of pure and applied scientific research to their business will be beneficial and get them to organize properly balanced departments for this purpose, their competitors will be obliged to follow suit in a short space of time if they expect to survive.

We have two distinct types of research laboratories to look to for precedent and ideas at the present time,—institutional and industrial. The first has a great work to perform in the early development of research workers. The second, which might be termed the graduate school, has also an important function in providing the young research worker turned out by the institutional laboratory with the facilities and character of problems that will enable him to apply his theoretical training to definite and beneficial ends that are vital to the very existence of our industrial life.

SOME REMARKS ON COÖPERATIVE METHOD OF ENGINEERING EDUCATION.

BY V. KARAPETOFF.

It is true that a student in engineering gets more out of theoretical subjects if he has had some previous practical experience in the same branch of work. The theory appears more tangible to him and he has more judgment as to the relative importance of various factors. It is also true that a student gets more out of his shop or testing experience when his first steps are guided by a competent instructor. Practical experience during the college course also has some other advantages; for example, it is not so humiliating to be in a subordinate position or ask foolish questions before one gets his degree. Again, those unfit for practical work can early find this out, and those particularly fit for a certain kind of work early establish valuable connections with suitable firms.

Shop experience for students is also good for colleges themselves, because it helps to keep them in touch with up-to-date practice and keeps the teachers on the qui vive for all kinds of unexpected practical questions. It is also good for the shops to have a sprinkling of college students among their workers and foremen.

But in spite of all these advantages of coöperative systems, the big question is, can such a system be actually carried out efficiently, without detriment to the academic instruction? In colleges situated near industrial centers the schedule calls for a change from school to shop and back every few weeks, but in a university like Cornell remote from large factories, each shop period must be at least one term long.

The shop conditions are such that men have to have long hours and much monotonous routine work. If left alone they chafe because of alleged waste of time, and if they have classes in the evening and have to write reports they get tired out and lose all interest in either shop or theory.

If the intention is to still limit the whole course to four years, then this can be done only to the detriment of theory and of scholastic academic atmosphere; if the whole course be proportionately lengthened then there would be a great temptation to go to schools which have no coöperative system and offer the same degree in four years.

The present cry is to elevate the engineering profession, to make the engineers broader in their economic and political views and also to give them a more thorough scientific training. There is no question that a shop experience would be a useful factor in both respects, provided that the unsystematized observations made there are properly interpreted and generalized by broadminded experts. Otherwise, the shops would tend to narrow down the student's horizon, by emphasizing firmly established things rather than imagination and search for new relationships. It is quite possible that with properly organized shops and laboratories in the college itself the good sides of shop experience could be preserved without their disadvantages.

Experimental psychology and especially late tests on students and on army soldiers show tremendous differences among men who have hitherto been assumed to be of about the same mental caliber. Therefore, fixed curricula and the prescribed quantity of work seem now more absurd than ever, because with two men the same amount of work does not correspond even approximately to the same mental stimuli and response. From this point of view it is wrong to advocate shop experience or to be against it for all the students. Some men would undoubtedly become better and more useful engineers with the coöperative system, while others would be simply dulled by it. For these "others" the place of the shop should be taken by extra chemistry, economics, differential equations, psychology, research, athletics, art, or whatnot, according to their mental, volitional and emotional type.

In colleges situated near industrial centers the coöperative system can be carried on by changing from shop to school every week or two. No definite conclusion can be gained at the present time as to the absolute success of this system as carried on in two or three well-known universities, notably in Cincinnati and in Pittsburgh. It is quite possible that such a system can be quite successful with a proper organization, and with teachers who believe in this system and who put inspiration in it. It probably works well with some students and others probably hate it heartily.

It would seem that changing at frequent intervals from one form of activity to another should involve considerable waste of time in acceleration and retardation. Even with ordinary regular recitations in a subject say twice a week the students seem to forget a great deal between two recitations.

Summer vacation would seem to be the proper and natural time for practical experience, or a whole year taken off before the senior year. It would not be too much of a hardship to require each student to spend the whole summer before his senior year in good hard practical work and to write a report on it as part of the requirements for graduation. This was a requirement in the C. E. College in Petrograd from which the writer was graduated. Additional inducements might be given students for spending their other vacations in practical work, provided they present suitable reports giving their experiences and an analysis of the same. Even academic credit could be given for such work under properly safeguarded conditions.

The problem of shop or no shop during the college course is not a burning or important one at the present time. The paramount problem is that of adaptation of education to the individual. Recent psychological studies show such tremendous differences in individual abilities and in the kind of stimuli necessary to inspire men to do their best that it seems like a crime and a folly to put thousands of young men each year through the same standardized grind. The next problem is to test your students at frequent intervals as to the state of their soul (not the amount of actual information) and to prescribe the necessary treatment. So a skilled photographer watches his plate during the process of development and adds this or that ingredient to his solution according to the state of the emulsion and the character of the details that are showing. We teachers, on the other hand, put hundreds of plates in a big tank and turn the crank, hoping that the average development would be about right.

Every few years we get alarmed at our results, and then like a pendulum we swing from one extreme in educational methods and curricula to another. It is time to understand that there is no universal method of education applicable to a large group of men, and that the problem is to keep on analyzing each student during his course and giving him such stimuli as he may need. This, of course, presupposes that we are clear in our minds as to our final product desired, and this is the broadest problem that we educators are called upon to consider and to solve. And there is again a danger there in settling upon just one solution; it is well to remember that it takes all kinds of people to make up this world.

THE UNCONSCIOUS PLAGIARIST.

BY G. I. MITCHELL,

Assistant Professor of Mechanical Engineering, University of Pittsburgh.

The honor of the technical profession is always high, the technical man guards his statements with jealous care and is generally careful to acknowledge the source of any idea not his own. But what are we to think of the authors of technical books who permit matter to appear in their pages that has been taken from copyright material already in existence?

Take the case of the college professor who, let us say, is the head of the mechanical department and is teaching machine design. Not being satisfied with the machine-design texts already in existence, perhaps because the order in which the work is arranged does not agree with his opinions of the subject or because the various relations developed do not meet with his approval, he gets together a set of notes, has them mimeographed and hands a set to each of his students.

Because these notes have been arranged according to the professor's particular notions he finds that they just suit his fancy, he can teach the subject with less friction and with less effort on his part—he does not have to correlate his ideas with those of another. He soon comes to be a firm believer in the fact that he has hit upon an ideal method of teaching his subject and condescends to have his notes published as a textbook that others may have the benefit of his broad intelligence.

Very good. He has been actuated by the best motives. But let us see how these wonderful notes have been collected. Did he sit down at his desk and evolve them from his own mind? The chances are very few that he did. No, he consulted every published text that he could get his hands on and picked out the parts that best suited his own ideas, one part from one author and another part from a second, and so on. Page after page of his notes was copied verbatim from other men's books, the professor merely running in a few words here and there to avoid a too abrupt change from one authority to another. Since he was simply compiling these notes for his own use, he was not careful to give reference to the men who were responsible for the subject matter.

After the elapse of a few years the professor has forgotten just who he consulted, has forgotten just how he got these notes together, so that when he makes up his mind to publish his text he simply bundles the pages together and sends them off to his publisher. When the book appears it is submitted to the public as a ''new and better'' text in machine design. It finds its way into schools, the men from whom the author cribbed various parts read the new text and are somewhat surprised to find page after page of their own material. Letters begin to pour into the office of the publisher, causing the publisher much discomfort. But what can the publisher do? He has printed the text in good faith, depending upon the integrity of the author to prevent unpleasantnesses of this nature, but the publisher is more or less responsible, and to say the least, is in a bad position. The author himself loses caste and is regarded as a thief by his brothers.

The remedy is easy to find. Let every author of a book of this kind search his notes with care and wherever questionable material is found, let full credit be given or let him give the old material new treatment so that it will appear in his new book in the author's own words. If the book is worth while it is certainly of the utmost importance that the writer keep his escutcheon clean, with his name placed high in brilliant letters on the roll of his profession.

REPRESENTATIVES OF THE SOCIETY AT THE DIFFERENT INSTITUTIONS.

Akeley, L. E., University of South Dakota, Vermilion, S. D.
Anderson, D. S., Tulane University, New Orleans, La.
Anderson, F. Paul, State University of Kentucky, Lexington, Ky.
Atkinson, T. W., Brooklyn Polytechnic Institute, Brooklyn, N. Y.
Ayer, Fred E., Municipal University of Akron, Akron, O.
Baender, F. G., University of Arkansas, Fayetteville, Ark.
Baker, Ira O., University of Illinois, Urbana, Ill.
Barnes, A. F., New Mexico A. and M. College, State College, N. M.
Bass, Frederic, University of Minnesota, Minneapolis, Minn.
Becker, A. J., University of North Dakota, University, N. D.
Benton, J. R., University of Florida, Gainesville, Fla.
Bishop, F. L., University of Pittsburgh, Pittsburgh, Pa.
Boardman, H. P., University of Nevada, Reno, Nev.
Boardman, H. S., University of Maine, Orono, Me.
Bolton, F. C., A. and M. College of Texas, College Station, Tex.
Boyle, A. C., University of Wyoming, Laramie, Wyo.
Brackett, B. B., South Dakota State College, Brookings, S. D.
Bringhurst, J. H., Drexel Institute, Philadelphia, Pa.
Brooks, J. P., Clarkson College, Potsdam, N. Y.
Browne, Wm. Hand, North Carolina State College of A. and E., West Raleigh, N. C.
Burger, W. H., Northwestern University, Evanston, Ill.
Butler, G. M., University of Arizona, Tucson, Ariz.
Constant, F. H., Princeton University, Princeton, N. J.
Cory, C. L., University of California, Berkeley, Calif.

Covell, G. A., Oregon Agricultural College, Corvallis, Ore.

Daggett, L. A., University of North Carolina, Chapel Hill, N. C.

Dargan, F. T., Clemson College, Clemson College, S. C.

Dodge, H. L., State University of Iowa, Iowa City, Iowa.

Doggett, L. A., United States Naval Academy, Annapolis, Md.

Duffey, C. F., University of Porto Rico, Mayaguez, P. R.

Drinker, H. S., Lehigh University, Bethlehem, Pa.

Earle, S. B., Clemson College, Clemson College, S. C.

Faig, John T., Ohio Mechanics Institute, Cincinnati, O.

Felgar, J. H., University of Oklahoma, Norman, Okla.

Ferris, Charles E., University of Tennessee, Knoxville, Tenn.

Fuller, A. H., Lafayette College, Easton, Pa.

Graham, Wm. P., Syracuse University, Syracuse, N. Y.

Greene, Arthur M., Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

Hazeltine, L. A., Stevens Institute of Technology, Hoboken, N. J.

Hodgkins, H. L., George Washington University, Washington, D. C.

Hollis, Ira N., Worcester Polytechnic Institute, Worcester, Mass.

Hoskins, L. M., Leland Stanford Jr., University, Stanford University, Cal.

Howe, Chas. S., Case School of Applied Science, Cleveland, O.

Humphreys, D. C., Washington and Lee University, Lexington, Va.

Jablow, Charles, Oklahoma A. and M. College, Stillwater, Okla.

Jackson, D. C., Massachusetts Institute of Technology, Cambridge, Mass.

Jenkins, A. Lewis, University of Cincinnati, Cincinnati, O.

Jones, C. R., West Virginia University, Morgantown, W. Va.

Kavanaugh, W. H., University of Pennsylvania, Philadelphia, Pa.

REPRESENTATIVES AT THE DIFFERENT INSTITUTIONS.

Kenerson, W. H., Brown University, Providence, R. I.
King, R. S., Georgia School of Technology, Atlanta, Ga.
Kunze, E. J., The Pennsylvania State College, State College, Pa.
Langsdorf, A. S., Washington University, St. Louis, Mo.
Lyman, R. R., University of Utah, Salt Lake City, Utah.
McCaustland, E. J., University of Missouri, Columbia, Mo.
McKibben, F. P., Union College, Schenectady, N. Y.
McNair, F. W., Michigan College of Mines, Houghton, Mich.
McRae, A. L., Missouri School of Mines, Rolla, Mo.
Magruder, Wm. T., The Ohio State University, Columbia, Mo.
Marston, Anson, Iowa State College, Ames, Iowa.
Mees, C. L., Rose Polytechnic Institute, Terre Haute, Ind.
More, Charles C., University of Washington, Seattle, Wash.
Nelson, J. R., University of Michigan, Ann Arbor, Mich.
Ogden, H. N., Cornell University, Ithaca, N. Y.
Patterson, L. L., Mississippi A. and M. College, Agricultural College, Miss.
Pegram, George B., Columbia University, New York, N. Y.
Pinney, J. C., Jr., Marquette University, Milwaukee, Wis.
Plant, L. C., Michigan Agricultural College, East Lansing, Mich.
Porter, J. B., McGill University, Montreal, Canada.
Potter, A. A., Kansas State Agricultural College, Manhattan, Kans.
Powers, W. P., Pratt Institutute, Brooklyn, N. Y.
Randolph, L. S., Virginia Polytechnic Institute, Blacksburg, Va.
Raymond, H. M., Armour Institute of Technology, Chicago, Ill.
Raymond, W. G., Iowa State University, Iowa City, Iowa.
Richards, C. Russell, Cooper Union, New York, N. Y.
Robinson, Max B., University of Akron, Akron, Ohio.
Rockwell, E. H., Tufts College, Tufts College, Mass.
Rodman, W. S., University of Virginia, University, Va.
Rosebrugh, T. R., University of Toronto, Toronto, Ont.

Russell, W. B., Franklin Union, Boston, Mass.
Scullin, A. J., The Catholic University of America, Washington, D. C.
Shaw, H. B., Doherty Training Schools, Toledo, Ohio.
Snow, C. H., New York University, New York, N. Y.
Sorensen, R. W., Throop College of Technology, Pasadena, Calif.
Springer, G. P., Maryland State College of Agriculture, College Park, Md.
Stone, W. E., Purdue University, LaFayette, Ind.
Stout, O. V. P., University of Nebraska, Lincoln, Nebr.
Stowe, A. M., University of Toledo, Toledo, Ohio.
Swain, G. F., Harvard University, Cambridge, Mass.
Taylor, T. U., University of Texas, Austin, Texas.
Thomas, R. G., The Citadel, Charleston, S. C.
Titsworth, A. A., Rutgers College, New Brunswick, N. J.
Tracy, J. C., Sheffield Scientific School of Yale University, New Haven, Conn.
Turneaure, F. E., University of Wisconsin, Madison, Wis.
Votey, J. W., University of Vermont, Burlington, Vt.
Walker, P. F., University of Kansas, Lawrence, Kans.
Whitehead, J. B., The Johns Hopkins University, Baltimore, Md.
Williston, A. L., Wentworth Institute, Boston, Mass.

EDITORIAL.

A questionnaire was recently sent out by the editor of a technical journal devoted to a highly specialized subdivision of one branch of engineering asking among other questions if it were thought wise to have a chair devoted to that particular subdivision in certain engineering schools. The field of this subdivision is large, the applications are numerous and the chances for further developments are excellent.

Should a chair be established? This at once brings up the question: What is the aim of engineering education? Of education? The question is an old one and in these days of specialists we sometimes forget the way over which we have come to our present position. We begin to think that we should train specialists so that the graduate may start at once to produce in his chosen field of endeavor. We forget that production is the result but not the aim of education. The aim of education is to produce a man who can think straight, who can analyze problems correctly so that a solution may be obtained and who has confidence in himself and his results. To do this there must be a thorough training in fundamentals and these must be emphasized even if no time can be given to the specialists.

In addition to the above point, the highly special branches are unwise because many students do not and cannot know what particular subdivision they are to enter upon on graduation. Many have prepared for one line of endeavor only to find it necessary, on account of changes in condition, to follow another. Because of death or business changes some who have depended on relatives or friends for a definite position on graduation have found it necessary to take up work for which their preparation has not been as complete as it should be.

Our plea is that education should be so thorough in the elements of our profession that the graduate is prepared by little extra study alone to enter any special field of work. The man who can reason from a thorough grounding in mathematics, physics, chemistry and their developments, and in social sciences; who can read what others say in one or two foreign languages; who can express himself clearly and forcefully in his own language and by drawings need not fear to enter any branch of engineering.

Our endeavor in arranging new curricula should be to give a thorough grounding in fundamentals rather than to include the many specialized divisions of engineering.

ARTHUR M. GREENE, JR.

COLLEGE NOTES.

The Kansas State Agricultural College on September 29, 1919, had an enrollment of 500 students in its collegiate engineering courses.

Construction was started on September 24, 1919, on an addition to the Engineering Building which will cost about $200,000, and will provide additional facilities for housing the departments of electrical engineering and civil engineering.

Missouri School of Mines.—The Missouri School of Mines has just issued a bulletin on "A Bibliography on the Roasting, Leaching, Smelting and Electrometallurgy of Zinc." This is a book of about 400 pages and can be had free of charge by those interested in zinc metallurgy.

The following special lectures were delivered before the Missouri School of Mines students in October:

"Treatment of Refractory Ores by the Wet and Dry Chlorination Methods," by F. G. Moses, hydrometallurgist, U. S. Bureau of Mines, Salt Lake City.

"Electrolytic Zinc," by Earl S. Bardwell, superintendent ferro-manganese department, Anaconda Copper and Mining Co., Great Falls, Mont.

"Electrolytic Copper Refining," by Earl S. Bardwell, superintendent ferro-manganese department, Anaconda Copper and Mining Co., Great Falls, Mont.

"The Use of Air Lift Pump on Tailings Disposal at Hurley, New Mexico," by H. T. Abrams, manager, Air Lift Department, Ingersoll-Rand Co., New York City.

THE NATIONAL COMMITTEE ON MATHEMATICAL REQUIREMENTS.

The National Committee on Mathematical Requirements was organized in the late summer of 1916 for the purpose of giving national expression to the movement for reform in the teaching of mathematics which had gained considerable headway in various parts of the country.

The membership of the committee at present is as follows:

Representing the colleges:

A. R. Crathorne, University of Illinois,
C. N. Moore, University of Cincinnati,
E. H. Moore, University of Chicago,
D. E. Smith, Columbia University,
H. W. Tyler, Massachusetts Institute of Technology,
J. W. Young, Dartmouth College (chairman).

Representing the secondary schools:

Vevia Blair, Horace Mann School, New York (representing the Association of Teachers of Mathematics in the Middle States and Maryland),
W. F. Downey, English High School, Boston (representing the Association of Teachers of Mathematics in New England),
J. A. Foberg, Crane Technical High School, Chicago (vice-chairman) (representing the Central Association of Science and Mathematics Teachers),
A. C. Olney, Commissioner of Secondary Education, Sacramento, California,
Raleigh Schorling, The Lincoln School, New York,
P. H. Underwood, Ball High School, Galveston, Texas,
Eula Weeks, Cleveland High School, St. Louis, Mo.

Last May the committee was fortunate in securing an appropriation of $16,000 from the General Education Board, which has made it possible greatly to extend its work. This work is being planned on a large scale for the purpose of organizing a nation-wide discussion of the problems of reorganizing the courses in mathematics in secondary schools and colleges and of improving the teaching of mathematics.

J. W. Young and J. A. Foberg have been selected by the committee to devote their whole time to this work during the coming year. To this end they have been granted leaves of absence by their respective institutions.

The following work is being undertaken immediately:

1. To make a careful study of all that has been said and done here and abroad in the way of improving the teaching of mathematics during recent years.
2. To prepare a bibliography of recent literature on the subject.
3. To make a collection of recent textbooks on secondary school and elementary college mathematics.
4. To prepare reports on various phases of the problem of reform. Eleven such reports are already under way and others are being projected.
5. To establish contact with existing organizations of teachers with the purpose of organizing a nation-wide study and discussion of the committee's problem. The committee hopes to induce such organizations to adopt this problem as their program for the year. It is ready to furnish material for programs and also to furnish speakers at meetings. The organizations in their turn are to furnish the committee with the results of their discussions and any action taken. In this way it is hoped that the committee can act as a clearing house for ideas and projects and can be of assistance in coördinating possible divergent views entertained by different organizations.
6. To promote the formation of new organizations of teachers where such organizations are needed and do not exist at the present time. These organizations may be sectional, covering a considerable area, or they may consist merely of local clubs which can meet at frequent intervals for the discussion

and study of the problems of the committee. It is hoped that such clubs can be organized in all the larger cities where they do not already exist.

7. To establish contact directly with individual teachers. The committee feels that this is necessary in addition to their work through organizations in order to induce such individuals to become active and in order to make the work through organizations effective. Plans for establishing this contact with individuals on a large scale are under consideration, possibly through the publication of a Bulletin. These plans, however, are as yet in a tentative stage.

Organizations can be of assistance by sending to the committee a statement of the name of the organization, its officers for the coming year, the time and place of its meetings and information regarding proposed programs. If any organization has within the last ten years issued any reports on topics connected with the work of the committee, copies of such reports should, if available, be sent both to Mr. Young and Mr. Foberg. If this is impossible, a statement regarding the character and place of publication of any such reports would be welcome.

Individuals can be of assistance:

1. By keeping the committee informed of matters of interest that come to their notice;
2. By suggesting ways in which the committee can be helpful;
3. By sending to the committee in duplicate reprints of any articles they publish on subjects connected with the committee's work;
4. By furthering the work of the committee among their colleagues, organizing discussions, etc.

It is not too much to say that the existence of this committee with its present resources gives the teachers of mathematics, both individually and through their organizations a unique opportunity to do really constructive work of the highest importance in the direction of reform. They can surely be counted on to make the most of this opportunity.

BULLETIN

OF THE

Society for the
Promotion of Engineering Education

Published under the supervision of the Publication Committee:
Arthur M. Greene, Jr., John F. Hayford, F. L. Bishop, *Editor*.
Address all communications to the Editor, University of Pittsburgh, Pittsburgh, Pa.

VOL. X   LANCASTER, PA., DECEMBER, 1919   NO. 4

TABLE OF CONTENTS.

Present Status of Industrial Life of This Country. C. F. Hirshfeld. 118
Freshman Orientation. A. C. Baebenroth 124
Discussion—Engineering Education. H. P. Boardman 133
A Professor's English. P. B. McDonald 140
Letter to the Editor 143
Editorial 144
College Notes 145
Committee No. 22, Intelligence Tests 147
Appointments by the President 148
New Members 148
Sections of the Society 149
Joint Meeting with the A. A. A. S. 150

PRESENT STATUS OF RESEARCH IN THE INDUSTRIAL LIFE OF THIS COUNTRY.*

BY C. F. HIRSHFELD.

The study of history reveals a great similarity in the social and economic conditions following wars of great magnitude. There is always a period of topsy-turvy-dom during which radicals of all kinds command large audience and during which individuals and nations act as though they had been relieved suddenly of all historical restrictions and bonds and were free to proceed unhampered in the pursuit of any sort of evolutionary or revolutionary scheme which met their individual or collective fancies.

This period always flows gradually into one in which the necessity of continuing an ordered social life is appreciated by the great majority, and the world, or that part of it effected by the war, settles down once more to the production of wealth and the pursuit of happiness upon a plane and according to methods not greatly different from those in use before the cataclysm.

The real lessons of the war and the lasting results thereof are seldom appreciated until they can be viewed in retrospect and often through a vista of many years.

The present situation bids fair to duplicate the past. We are apparently just emerging from topsy-turvy-dom into a more or less ordered existence. We are beginning to appreciate the fact that sociological surgery, like human surgery, has as yet certain limitations. We may perform operations of some sorts without seriously endangering a fairly normal patient but when the severity of the operation exceeds a certain limit the patient is apt to succumb to shock even after a most successful operation from the surgeon's viewpoint.

---

*Read at the Mid-West Sections Meeting, A. S. M. E., Indianapolis, Ind. October 25, 1919.

I feel that it is well to bear such facts in mind when discussing research and its application to industry in this country. There seems to be a popular impression that industrial research did not exist in these United States before the war, that the phenomenal performance of Germany and her allies was due to the development of such research in Germany, and that we are now about to take up work of this sort in characteristic American fashion, producing over night a dozen or more research laboratories for every one originally possessed by Germany. The facts are that industrial research was fairly common in this country before the war, that Germany's performance, in so far as it depended upon research, was largely based on the utilization of the results of research rather than upon the uncovering of new facts, and that to multiply research laboratories and facilities in this country at too rapid a rate would lead to chaos, waste and business failure instead of acting as a healthy stimulant to a slightly neurotic patient.

We must not expect the war to revolutionize over night our methods of producing and of doing business any more than we can expect it to suddenly "emancipate" labor. The fact that we are now trying to enunciate and codify principles governing the relations between employer and employee which have been in the process of development for decades should not lead us to attribute the principles themselves to the war. The disturbed conditions incident to the war merely serve to focus attention upon the problem. This is a convenient time for taking account of stock before we start out once more in ordered fashion to develop still further. Similarly, there has been growing in industry during the two decades just past an appreciation of the fact that refined methods of analysis produce results, and the war has simply served to focus attention upon the haphazard way in which industry has utilized and adopted such methods. This is unquestionably the time at which we can best study what we have achieved in the application of industrial research and at which we can best plan the future development in so far as it is controllable. If you will look over the papers which have been presented before this organization and others of similar type during the past three years you will discover that some of the best minds in the country are already engaged in just such a task.

There is another popular impression which I believe to be basically incorrect. Research is regarded as a name for the efforts of individuals who spend their working hours in physical and chemical laboratories delving into the so-called secrets of nature for the purpose of extracting hitherto hidden facts or formulas which may be expected to have commercial value. To me this is entirely too narrow an interpretation. I regard research as the search for facts and I regard industrial research as the quest for facts which have immediate industrial value. Research as now pictured by the multitude may be called material research. Industrial research must include many other varieties if it is to achieve its end, particularly economic research and sociological research. Questions of economic and sociological types are just as amenable to laboratory treatment as are problems in the proper method of heat treating a given grade of steel or in the modification required to take account of mass action in conducting chemical reactions on a commercial scale.

If research is regarded merely as the determination of facts, every department of industry is a proper field for research and can possibly be benefited thereby. In fact, if this definition be adopted, modern research is merely an organized or ordered development of the methods which have been in use for generations. Every executive and every individual in charge of industrial activities has had to make decisions and in so far as it was possible, has in general determined facts on which to base these decisions. Unfortunately the determination of facts in many different lines by one individual and at the rate required to keep pace with the evolution of the industrial world is impossible and as a consequence most of our successful executives have fulfilled Elbert Hubbard's definition—they decided quickly and were sometimes right. The marvel is that they were right in such a large proportion of their decisions.

All that we can hope to do by research is to make available for such men the facts upon which to base a greater proportion of their decisions. They will thus have to depend upon judgment, instinct, intuition, or guess, as you like, for a small proportion and their work will be just that much nearer to an absolute basis.

I do not like to pose as a prophet—I prefer to have some honor in my own country if it is obtainable. However, I believe it is patent that our industrial development on its material side is already out shipping the economic and sociological development required to stabilize it. We are learning to produce in greater quantities and in greater varieties daily and our attention is so focussed on this work that we are giving insufficient thought to the problems of finance, distribution and utilization and to the desires, ambitions and hopes which we are creating.

The literature of the day is so full of articles giving the results of investigations in the field of heat treating steel that no manufacturer of steel products can plead ignorance of the fact that exact information is available if he chooses to make use of it. On the other hand, where is that same manufacturer to learn the facts with respect to the advisability of making plant extensions during periods of rising as against falling prices, or during periods of decreasing business failures as against periods of increasing failures? Or where is he to determine facts with respect to the reasons why bonus systems succeed in some places and fail in others? Or where is he to obtain information with respect to the relationship existing between the rate of increase of wages in his plant or in his industry and the rate of increase of living costs? Research in such fields is conducted to a limited extent and certain publications are issued for the purpose of distributing the results but comparatively few industries seem to have recognized the necessity of applying this sort of research to the problems of industry.

Does it not appear that in the sudden public appreciation of the advantages to be gained from material research we are threatened with a one-sided development which can only lead to trouble unless corrected at the start? Does it not appear desirable for organizations such as this Society to bring to the attention of the public the fact that no decision of any sort need rest on guess work if facilities for all the necessary types of research are available?

I am now concerned with the way in which research is to be conducted or financed. For my present purposes it is immaterial whether the federal government pays for this, the state government pays for that and the individual producers or a group of producers pay for something else. I am concerned with developing appreciation of the fact that what we now call research is merely an extension and refinement of methods previously in use, with driving home the fact that material research is only one of the numerous varieties required to continue the present industrial development, and with spreading the doctrine that it is good business to obtain such information as is necessary to enable our industrial executives to base their decisions more largely upon determined facts and to a lesser extent upon so-called judgment. I feel particularly that the continued stable development of the industrial age depends almost entirely upon our ability to bring to our executives those facts which will enable them to stabilize the social structure within which industrialism is contained and has its growth. I see no way of doing this other than by painstaking research along economic and sociologic lines and at such a rate as to keep pace with the results attained by the application of material research which industry itself may be depended upon to develop at an ever increasing rate.

I admit that my program is large—but the problem with which we are faced is large. Our country, in common with the rest of the civilized world, has developed to a point where the conditions we have created are leading us to question the adequacy and even the validity of what we have regarded as fundamental precepts in the relation of man to man and of nation to nation. Some of us attribute this condition to the rapid development of industry, others to the growth of social consciousness and still others to the continued upward progress of man. Attribute it to what you will; it is a fact that parallel to our development of factories, modern methods of production and of ways and means of bending natural forces and laws to our ends there has occurred a development in human relations about which we have much less basic knowledge and over which we can exercise correspondingly less control. Is not a rather large program justified by such a set of conditions?

FRESHMAN ORIENTATION.

BY A. C. BAEBENROTH,

Professor of English, Syracuse University.

In 1916 the writer composed individual letters on the subject of a general informational course for freshmen in the Smith College of Applied Science at Syracuse University. These letters were sent out to a selected list of engineering school executives whose names appeared in the March, 1916, BULLETIN. The letters were not of the questionnaire type, but after a brief explanation of the idea in the mind of the writer, asked simply for information concerning the methods employed by the faculty of the engineering college in bringing freshmen in touch with college ideals. Forty-two letters were sent out.

Thirty-nine replies were received. Practically every one of these went somewhat into detailed explanation. Fourteen were accompanied by enclosures of booklets that were offered as concrete evidence of what was being attempted. These booklets are as a rule published by the university Y. M. C. A., or by an enterprising student or society. It developed upon analysis that in the majority of schools the attempt to bring freshmen into line was limited to a single lecture by the dean. Only four of the schools had elaborated on the introductory lectures given by the president and the dean. Moreover the course at Brown University is for the whole university rather than for the engineering college as a unit. Some of the titles noted below have been used at Brown. Purdue University has an excellent course of four required lectures on "Health and Efficiency in Your University Course." The University of Illinois has a more extensive course of lectures for freshmen, and the University of Idaho has a required series of eight matriculation lectures of a general nature.

Many of the letters revealed a sincere desire to accomplish something in the way of properly adjusting freshmen to their new environment. An equal number of deans stated frankly that although the need was great, nothing tangible had been done. A few spoke reminiscently of class advisory systems and other plans that had fallen into innocuous desuetude. "Several years ago an hour was set aside—unfortunately the practice has not been maintained." "Student conduct is regulated by the exactions of the individual professors." "For some time we have had in mind the giving of a course of lectures to freshmen—nothing definite has been done." "We are considering the introduction of lectures." "In the past more or less sporadic efforts have been made." "You will see that a good deal of this is pretty vague."

Because a very large number of those who took time to answer the letter fully, asked for the courtesy of a response in case a plan was worked out at Syracuse, the writer is using the present method of explaining the simple results of our experiments.

1. A course in "freshman orientation" was approved by the faculty in the spring of 1917. The work was to be conducted under the supervision of the department of English, with compulsory attendance for all freshmen. The course was scheduled to meët once each week. Students were alphabetically seated so that a cumbersome roll call was not necessary, the instructor taking the attendance after the lecture had begun. The attendance was uniformly good to the end of the course, the men showing no tendency to "cut." No doubt the caliber of the men who were invited to speak, explains in part at least the excellent attendance record. Close attention to details was encouraged by having it unobtrusively passed about among the men that an examination of some kind would be given at the conclusion of the course.

2. It was thought best to have two lectures at the very outset on "Right Living." In order to preserve the academic spirit, the creation of which it was one of the objects of the course to stimulate, it was finally decided not to have a medi-

cal man, but to invite one of our professors from the department of biology to explain the origin of life, at the same time leading by means of scientific exposition into the subject of sexual hygiene as a natural climax. Two lectures were devoted to the accomplishment of this: the first given over entirely to an elementary exposition of the evolution of life in the lower forms manifested in nature; the lecturer not as much as alluding to the matter of right living as applied directly to the student problem in the solution of which the lecture was to assist the freshman. As it turned out, the lecturer did not reach the purely human side of his subject until the last half hour of the second lecture. And it was not until the closing minutes that he spoke "straight-out" to the men about their social duties. The writer has listened to numerous lectures by "college doctors." He has several times invited a Y. M. C. A. secretary who was at the same time a physician, to lecture to his freshmen. But never has the quiet cumulative effect been so strong as in this instance. There was no room here for the near-salacious "side-lights" that undergraduates in certain institutions purposely go to enjoy in the lecture on such topics. All the authority of science was behind this lecture, and all the dignity that comes with honest exposition of such a subject went into the final and direct application to the freshman. The lecturer, of professorial rank, and a man with children in the adolescent stage, had his class of young men "sewed up tight" without once having had recourse to tricks of oratory or to the juggling of horrifying statistics.

Concerning this most important of all the topics in a course of orientation, the moral is clear. *First,* the lectures should be scheduled at the very beginning of the fall term, before the student has fallen into the temptation that is almost certain to come in some form to the youth who is for the first time, probably, separated from the restraining influences of home and tried friends. *Secondly,* as concerns the manner of presentation, the lecture should be leisurely and expository in tone. In order to have it so, a man from the faculty is the best choice. A display of surgical monstrosities, together with a flaring account of the accompanying tortures, secures no practical results beyond possibly frightening the weak. The manly honesty and straightforwardness of biological elucidation appealed to the red-cheeked, straight-up-and-down, virile youths in our course, who would have resented an attempt to frighten them, but who allowed themselves to respond quickly to right knowledge.

3. Our dean gave the third lecture, "The Qualities of a Good Engineering Student." This at once served to give the men an idea of what would be expected of them during their four years at college. The dean as the head and forefront of the college can by means of such a discourse mold the plastic and willing mind according to his ideal of engineering.

The fourth lecture was given by the dean of the Teachers' College on "System in Study." Then followed a period devoted to the exposition of the "Honor System," which is in vogue in the engineering college, and concerning the merits of which representative seniors spoke, one from each of the coördinate departments. At another meeting of the course certain senior members of "Tau Beta Pi" explained the value of that society to the student body of the college.

The "Religious Life of the Student" and "Tobacco and Liquor" followed, as being practical in their application to the daily life of the men. Our professor of botany was willing to tell the men about their duties in the church. He, also, preferred the explanatory to the hortative style. The professor of economics gave an address on tobacco and liquor, and enlivened his statistics by direct appeal to the good judgment of each individual. In the matter of discussing the tobacco problem before students, it seems to the writer to be best policy simply to extend the line of thought opened up by President Hyde of Bowdoin College in a frequently printed "Address to Freshmen." His method is to warn and guide, and not to condemn.

4. Then followed two lectures that were intended to give the freshman a new slant on the value of his course in Eng-

lish: "The Value of English Composition" and "The Value of Public Speaking." As the head of our department of chemistry had collected valuable evidence of the relation between a graduate's ability to express himself and his chances of securing a good position, he was chosen to impress the class with the importance of the study of English. The diabolical subtlety of this choice will be appreciated when it is recalled that the freshman who is skeptical of the value of English in engineering does not suspect the professor of chemistry of prejudice on this subject. The moral is that a member of the science faculty will probably be more impressive than the professionally "interested" member of the literary faculty. The dean of our school of oratory gave a strong talk on public speaking. It is well at this point to emphasize the distinction between elocution and public speaking, because the engineer is not practically interested in elocution, and probably can not be interested even to the point of toleration. A man who is himself a model of the natural style of forceful platform address should be chosen for this important lecture. The head of our department of history lectured on "The Development of Style in Lincoln's Addresses." Our professor of Biblical languages and literature addressed the men on "The Origin of the English Bible."

One of the professors of the engineering faculty took the subject, "How to Read Technical Magazines," after which the professor of civil engineering lectured on "How to Utilize the First Vacation." This was not, as might have been expected, the last lecture, but was pushed ahead in the schedule in order to prepare the mind of the student, to give him abundant time for reflection, and also to forestall definite plans that might conflict with his best interests from the point of view of engineering. Specific ways were not suggested, but the underlying principles of success in engineering in so far as the proper utilization of the long vacation is involved, were clearly analyzed, so that the average student should have been in a position to help himself intelligently in his choice of work. This plan avoids the paternal, straight-jacket method, and acts as a guiding force.

5. After this the head of our department of philosophy spoke on the theme "What is a University?" The direct application to the problem of the engineer lay in the proper orientation of engineering in relation to the other subjects taught in the university. "Factors of Success in College Life" followed, the points that were emphasized serving to elucidate still further the principles evolved in the preceding lecture.

In order that our men might secure their information about Syracuse University from authoritative sources, three lectures were given on the following interesting topics: "A History of the Campus," "Syracuse Customs," and "The Story of Syracuse Athletics." These more practical subjects naturally grew out of the general discussion of the immediately preceding lectures.

For "Syracuse Customs" we were fortunate to have available our Vice-Chancellor Emeritus, the only man connected with the university faculty who was present when his class was graduated in 1870. He has noted all the customs of the institution lovingly, and gave the men a talk they will never forget. Effective creation of the true spirit of *alma mater* can be accomplished by inviting a man of this type. The professor of architecture explained the physical growth of the university, at the same time calling attention to the architectural features to be enjoyed by the student. The subject of athletics was treated by the dean of our college of Liberal Arts, who was for many years a member of the board of stewards in charge of the Poughkeepsie Regatta, and the university representative on the intercollegiate board for the regulation of football. His experience not only gave him a command of the facts, but impressed the men with the importance of the reforms and true tendencies that should be encouraged if college athletics are to remain. Entertaining and fascinating as it was to have the early history of athletics unfolded, the lecturer did not consider it his mission merely to entertain.

By skilful grouping of material, and by apposite comment he drove home the lessons learned from the "athletic" mistakes of the past.

If these lectures helped the student to a more certain enjoyment of his university life, the concluding lectures assisted him in the intelligent appreciation of the countryside. The departments of botany, geology, and zoölogy can do a good service in freshman orientation by popularizing their technical lore in so far as it applies to the countryside adjacent to the campus. Contrary to the usual assumption, many undergraduates still are formidable walkers. If faculty members bemoan the degeneracy of the student body in this respect, it is probably because they are not on the road or in the field often enough to see the student taking his constitutional. And to those students who are inclined to remain shut in because they see no object in a country ramble, these lectures were a challenge: "The Birds of Onondaga County," "Neighborhood Geology," and "Wayside Plants and Flowers."

6. The following brief written examination was set at the last meeting of the course in May:

Name ten lectures given in this course. Characterize each in a sentence.

At this time, what lecture above all others seems most valuable to *you?*

Explain briefly in just what way this lecture has been of value to *you.*

7. Additional lectures for which speakers were available, but for which no time could be found, might be used in place of some of those given: "The Relation of Good Health to Success in Engineering" (this should be given by a man who is a model of physical and mental good health and who has been successful in engineering or executive work), "The Proper Illumination of Study Rooms," "The Human Element in Engineering," "If I were a Freshman Again," "Political Aspects of Engineering," "Law and Engineering," "Tau Beta Pi," "The Relation between Theoretical and Ap-

plied Mathematics," "What is History?", "The Relation between Culture and Engineering in the History of Mankind."

8. It will be noted that controversial or competitive subjects of the curriculum were with one exception avoided. A course that aimed to call attention to the merits of each field of engineering would sooner or later bring down upon itself the ridicule of the class. Professors would be misunderstood in their effort to give an impartial account of the virtues inherent in their "special" phase of engineering. The highest purpose of engineering will be most effectively served in such a course as this if the curriculum is avoided as much as possible; that is, if the curriculum is not directly discussed. An exception was made in the case of English because every professor of engineering knows, or should know, that the entering student is often antagonistic to first-year English, simply because he can not see its value or its bearing upon his engineering problems. The other and more fundamental preparatory subject, mathematics, needs no sustaining power of this kind because its value and immediate application are obvious even to the freshman.

9. The results of such a course are not sufficiently tangible to be measured. The full realization of its value can not come until several classes that have undergone the orientation treatment have graduated. It is not until we possess statistics covering a period of years that we can judge of the improvement the course has made in the morale of the student body.

10. One of the delightful features of the writer's experience with the first year of organization was the hearty and immediate coöperation he received from the members of other faculties of the university. Every member who was invited, consented immediately, even after it became clear in conference that a special angle was indispensable for effective treatment before an assembly of technical students.

It was the writer's method to introduce the speaker formally, presenting, as a part of the introduction, the facts of the speaker's position in the university, and reading a list of some of the most important of his publications. Such an introduction emphasizes the dignity of the speaker and of the subject to be treated. And whereas the freshman is especially prone to faculty worship during the first half of his year, and although the authority of the whole university organization is behind the man who speaks, with the result that reverence is secured in that way—still, it is well for the student to know that the professor has done more than merely teach his weekly roster of lectures year after year. Except in the case of an unusually prominent man, the student can not be expected to know what has been published, for the reason that he is not in the habit of consulting the learned periodicals. To cultivate a proper respect for solid achievement is part of the work of freshman orientation.

DISCUSSION—ENGINEERING EDUCATION.

BY H. P. BOARDMAN,

Professor of Civil Engineering, University of Nevada.

The report on "Engineering Education" by Professor Charles R. Mann shows many reasons for our shortcomings and is replete with pertinent suggestions which ought to produce results.

It seems to the writer that one of the best lines of suggestion in the report is that dealing with methods of teaching. If a scientific subject can be made interesting to students by the introduction of practical applications, its scientific value need not be lowered and the student will work harder and learn more. On the other hand it is not likely that every necessary step in the development of subjects like mathematics, physics and chemistry can be illustrated by practical problems or applications. Some years ago the writer talked with a young mathematics instructor of a secondary school who was starting work on a thesis in which he hoped to show how to teach the essentials of algebra by using only "real problems," or those which have significance in actual life. He maintained that the average high-school girl gains nothing of value even in mental discipline from the study of abstract algebra, as usually taught and that it would mean something to her if it could be related to actual life problems. He confessed later on that he was having extreme difficulty in formulating enough "real problems" to illustrate all of the points he wished to bring out. One trouble with the "real problem" is that it is not made to fit one subject like elementary algebra but often involves several branches of learning, some of which the student may not be advanced enough to understand.

The writer will give a little of his experience with the surveying detachment of the Section B, S. A. T. C., October—

December, 1918, though it was no doubt very similar to the experience of many others. This detachment included several experienced surveyors, who coöperated willingly in helping to instruct the others. Approximately one half of the detachment had not completed a high-school course and one fourth not even the eighth grade. The field work included the following, in about the order given: Transit and tape traverse, leveling, triangulation, topography by stadia transit and plane table. These were followed by a limited amount of plotting, but the interest lagged somewhat at this stage as the armistice had been signed and numbers of the detachment had no intention of following surveying as a business. The writer considers the computations as the most difficult part of surveying for the novice, so endeavored to equip this class for that part of the work. The first instruction given was in the elements of trigonometry. Algebra and geometry were not taught except as required in developing the trigonometry. The solution of right-angled triangles was applied after a few days to computing the latitudes and departures of the traverse courses run in the field, the coördinate system being explained and at once applied. As soon as the solution of oblique triangles had been explained it was applied to computing the triangles whose angles had been read in the field.

Most of the members of the detachment spent from three to five evenings per week in a voluntary study session lasting one and a half hours, in one of the engineering buildings. Thanks to the assistance of the experienced surveyors of the detachment, all of the others were taught these computations by the use of logs and naturals. The subjects of trigonometry and surveying were neither of them covered at all completely but both were covered in the essentials of most common application. The formulæ used in computations were in the main developed before the class by the writer by gradual steps so that all should have been able to follow them through and understand them; *i.e.*, their lack of even high-school mathematics should not have prevented them from following the demonstrations through. Of course all did not actually understand the work equally well and in fact several who had not completed high school gained a better understanding of the theory and computations than did one who stated he had been through calculus in college.

The writer would not, on account of the above experience, argue for admitting to his regular surveying course, students who have had no training in algebra, geometry or trigonometry. On the contrary, he considers it just as essential as ever to specify trigonometry as a prerequisite to surveying for engineering students. However, if more applications to surveying and other real engineering problems were used to illustrate the teaching of trigonometry perhaps the students would not have to "learn over" so much of that branch of mathematics as most of them now do when they attack surveying.

Surveying can usually be easily taught by doing actual practical surveying instead of merely by typical illustrative problems.

Some years ago before he took up teaching, the writer had an enlightening experience with two young engineers, graduates in civil engineering from a prominent state university in the Mississippi valley. They were sent out with the necessary equipment to tie in a group of buildings comprising a manufacturing plant and several houses, to the center line of a proposed canal, which center line they had assisted to stake out on the ground. They returned to the office with insufficient data to enable them to plot the buildings on a map of the canal line. What is more they did not seem to understand what other measurements were necessary until the writer went into the field and showed them. The writer believes, possibly erroneously, that this as the result of teaching surveying field work largely by means of detached problems intended to illustrate principles but not connected up into one comprehensive survey. At any rate in his twelve years of teaching experience, which was preceded by sixteen years of practical engineering work, the writer has always required his surveying classes to make actual field surveys of areas and compute and plot from their own notes. The results in general seem to justify the method. All locations are not equally favorable for this method but it is probably possible of application in most institutions.

In small institutions like the one with which the writer is connected, it is not usually possible for the faculty members belonging to the strictly engineering departments, to have complete control of the teaching of nontechnical subjects to engineering students, one reason being that other than engineering students are often in the same classes with the engineers, the instructional force being too small to provide distinct sections for engineers.

Partly on account of this condition but more especially to try to hold up the interest of freshman and sophomore engineers and show them why they spend so much time on preliminaries, the writer introduced in 1918 a course for freshmen entitled "A General Survey of Civil Engineering." It has not yet been given on account of the war conditions last fall but will be offered next semester as an elective. The aim of the course will be to show many of the practical applications in engineering of such subjects as mathematics, English, physics, chemistry and geology. It will not be merely a popular (or unpopular) lecture course but will involve a considerable number of computations and will endeavor to convince students that they need to understand much of the above subjects in order to be properly equipped for the later technical courses and for independent study along special lines in connection with the practice of engineering.

The writer has for a number of years given a course in current engineering literature. This has consisted of assigned readings and discussions from current engineering periodicals and technical society proceedings. The student is required to prepare his assignment, so he can give the gist of it orally, with the aid of brief notes if he wishes, explaining the illustrations if any, and discussing any controversial points.

The assignments are so made that each student will occupy from one half to a full hour period when his turn comes. It is a one credit course per semester and if there are more than four or five students in the class they meet for two periods per week so that each one will come on the program about once in every two weeks.

This was for some years made a requirement for senior civil engineering students, the idea being that they would get more out of the course than less advanced students, but recently it was made an underclass course, elective for freshmen and sophomores and it worked well during this second semester of 1918 and 1919 with a class of seven, including members from all of the engineering courses.

Many of the assignments are non-technical, such as discussions on engineering education, professional ethics, salaries for engineering work, the future of engineering, etc. The asking of questions and expression of personal views or statement of personal experience is encouraged. Since the instructor can not read all articles before assigning them, some points will be beyond the understanding of the students. This is well, for it often serves to show them their need of further education and experience.

The whole tendency of the course is to put the students in touch with real engineering life and develop a desire to keep up to date as well as to increase their interest in their technical studies. Incidentally, the effect on the instructor of the course is good also.

The writer does not think this course would work very satisfactorily in sections larger than about ten.

One does not want to be too hasty in discarding all the portions of a subject for which he cannot see immediate practical application. His experience may be too narrow to make him a good judge. Few engineering students know during their undergraduate days just what line of work they will follow, hence the college period is too early in life to specialize within narrow limits.

The war-time conditions of the past year and a half no doubt had a marked effect on Professor Mann and perhaps caused some modification of his report. The great emphasis placed on the idea that engineering and engineering education exist primarily to increase industrial production, was natural at a time when so large a proportion of our engineering effort was bent on increasing production to win the war. The writer is inclined to think that engineering is also concerned with the *reason for* the desired increase in production. During the war the wish to win the war and do it quickly made quantity and speed of production of paramount importance and cost of less importance than in time of peace. The author says on page 108 of the report that "The ultimate aim of engineering education has always been and still is more intelligent industrial production." The introduction of the qualifying word "intelligent" is very important and may mean the difference between an attempt to satisfy the economic need for a certain product, and an overproduction which would result in financial failure.

But there are large fields of engineering that are not concerned with industrial production, as that term is commonly used. Among these are sanitary engineering, landscape engineering, all types of amusement engineering and flood protection. In other words engineering primarily concerned with the welfare, pleasure or safety of humanity is not for the purpose of increasing production. No doubt that since the comparatively recent boom in "safety first" much has been done in safety and welfare engineering that was intended to increase production by improving working conditions and so satisfying the employees. But would it not sound better and in fact come closer to what ought to be the truth if we say that safety and welfare engineering are primarily for the benefit of the worker and should be practiced whether or not it can be proved that the result is increased production? This ideal is more often realized by the employer in these days than it was twenty or thirty years ago when little was done in such lines except as compelled by legal enactment.

The author shows in Chapter XVI that he appreciates these types of engineering which do not aim at increased production but the writer wishes to emphasize this phase a little more. When one speaks of the ultimate aim of engineering education, does it stretch the imagination very much to think of a time when the engineer, as well as many others will pause to inquire, "What is the increased production for"? Does it bear any resemblance to the case of the farmer who wished to "raise more crops to make more money to buy more land," etc., etc.? Are not *people* the most important product of this earth? Whatever our religion or philosophy of life (if we have any), we are *here* and is it not a worthy *ultimate* aim for us to try to make *here* a better place to live in, not merely for us but for everybody? Is it not a fact, and one for us to be proud of, that a very large percentage of engineering work does contribute directly towards making this earth a better place in which to live, even though the *immediate* aim of much of it is increased production? Even the military engineering of the United States and its allies in the great war, though it carried death to our enemies, we hope served to help make the world a better place in which to live.

This is a good time to call the attention of the engineering educators to the need of ideals which should lie back of our profession. If teachers of engineering students have no ideals or no vision beyond the immediate object of increasing industrial production, they will wake up some day to find themselves out of step with the progress of civilization and many of their former students will have outdistanced them in the matter of ideals as well as in the matter of remuneration for professional services.

A PROFESSOR'S ENGLISH.

BY P. B. McDONALD,

Assistant Professor of English, New York University.

The English used by engineering professors is probably the worst English used by teachers in this country; and the English of some contributors to ENGINEERING EDUCATION is nothing short of lamentable. At a time when the importance of English to the engineer is being emphasized in many high-sounding addresses and long-winded articles, the worst possible example is being set by the speech and writings of the engineering professors themselves. Students of engineering will never appreciate the value of good English until their teachers learn to express themselves in language suitable for a college graduate.

A teacher of engineering is supposed to think clearly, precisely, and logically. Yet, too many of them talk and write in a manner exactly the opposite. They use what Sir Arthur Quiller-Couch (Professor of English Literature in Cambridge University) calls "jargon" (page 100 of "On the Art of Writing"), of which the two main vices are "circumlocution rather than short straight speech" and the habit of "habitually choosing vague wholly abstract nouns rather than concrete ones."

The user of jargon, remarks this well-known writer, says "adverse climatic conditions" when he means "bad weather," and "in the case of John Jenkins deceased the coffin provided was of the usual character" when he means "John Jenkins' coffin was of the usual kind." He is especially addicted to such words as "case," "character," "instance," "nature," "condition," "thing," "concern," etc.

In a recent number of ENGINEERING EDUCATION a writer said: "In any complex undertaking which involves the efforts of many individuals we acknowledge at once the value of sympathetic coöperation made effective through coördination in reaching a common goal.'' This is a confused roundabout way of writing quite typical of articles in ENGINEERING EDUCATION. The writer meant simply that ''In complex undertakings men gain by coöperation,'' which is not a very startling thought, to be sure. Farther along in the same article mention was made of ''syllogistic cogency.'' It is to be hoped that readers who read so far knew what both those words meant!

In the same BULLETIN was this muddled sentence: ''During the period 1898–1900, while doing the executive work incidental to the fact that he was in charge of both the field and office work of the triangulation, precise leveling, and astronomic work of the survey, he was also active in improving methods and research work.'' The writer of that extraordinary conglomeration began another sentence thus: ''Extensive researches by him intended to determine the reasons, etc.'' Truly, as a recent article on modern English in the London Times remarks, ''the habit of verbosity reacts strongly upon the intelligence,'' and ''pleonasm is the original sin of language.''

To quote an American authority, the U. S. Geological Survey in its pamphlet entitled ''Suggestions to Authors,'' says of ''stilted and showy writing'' (page 63): ''Some members of the Geological Survey . . . never go anywhere . . . they invariably proceed. . . . Neither do they begin work; they inaugurate or initiate it.'' These writers, continues the pamphlet, say ''superficial circulation'' for ''surface water,'' and ''vegetational aspect of the vicinity,'' and ''The high-pressure area . . . accelerates the prevalence of westerly winds.'' Like the love-lorn Benedick in ''Much Ado About Nothing,'' they discard plain, honest words for a ''fantastical banquet'' of ''strange dishes.''

The Geological Survey's pamphlet suggests that such evpressions as these are over-used: ''from the standpoint of,'' ''on the basis of,'' ''along these lines,'' ''value,'' ''case,'' "instance," "quite," etc. It states that too many sentences are begun with "there is," "there are," "it is;" and it prints a page of superfluous words and phrases.

These suggestions should be enough to indicate what is wrong with the English of many engineering professors, particularly of some of those who contribute to ENGINEERING EDUCATION. Another criticism likely to occur to a critical reader of the BULLETIN is the lack of moderation shown by some contributors. Their statements would be truer and more interesting if they evinced a better sense of proportion. Individual writers are too apt to think that their particular hobby is the key to the universe. Thus, one writer recently decreed that "the student who even dimly sees, or vaguely feels, the truth that engineering is the foundation of our present civilization is more apt than others to be permanently well motivated." Aside from the poor English of this sentence, there might be doubt whether or not "engineering is the foundation of our present civilization," and whether, even if it is, a student should be encouraged to get a swelled head over it. W. L. Saunders, past-president of the American Institute of Mining Engineers, has hinted that engineers lack political influence because of "megalomania." Surely then, students should not be taught to "dimly see, or vaguely feel" that the universe hinges upon them. Engineering is, of course, very important, but there have been admirable civilizations that knew very little about it. And though our modern times make tremendous use of engineering, and though it is true that the engineer is not appreciated, the world is not likely to be impressed by statements that "engineering is the foundation of our present civilization." That is, such a point of view does not tend to improve the status of the engineer. It does not show the proper balance that begets confidence. Writers of articles in ENGINEERING EDUCATION should be particularly careful neither to overstate their case nor to make it wishy-washy. To interest readers, contributions should express the truth while avoiding platitudes.

A LETTER TO THE EDITOR (THIRD WRITING).

THE EDITOR,

Sir: Since June, 1919, I have been trying to get a "letter to the editor" published. I wished to criticize the English used by some of the contributors to the BULLETIN. After long delays and several re-writings and explanations to the officials of the Society, I find my criticisms and suggestions so much discouraged by the officials of the Society that I am disinclined to re-write my letter in full again, as has been requested.

My understanding of the matter is that in criticizing the English of the BULLETIN I must not cite specific instances, since that would be "too personal." Therefore, I would merely suggest that the English used by some of the contributors is exceptionally bad, and that it sets a poor example to students of engineering.

P. B. McDONALD.

NEW YORK,
November 12, 1919.

EDITORIAL.

Are there Enough Engineering Schools?—The demand for engineering graduates has become so pressing in the industries that the question naturally arises: is there a sufficient number of engineering schools in this country to provide a constant adequate supply of technically trained men for the industries? I believe there is not.

With the constantly increasing foreign trade which the United States is developing, the demand for different manufactured products must of necessity increase. The success of this foreign trade is dependent upon the constructive genius in industry to design and originate articles which the production and selling organizations place upon the market. Without the developed constructive organization in the industries, our foreign trade must fail. We have come to look upon Germany as possessing all the characteristics of a nation which we should avoid, but one thing is certain that its great success in foreign trade was due to the large number of highly trained specialists who worked in the industries.

Our manufacturers are recognizing more fully the advantages which arise from a technical staff composed of properly trained men. This recognition of the phase of applied science in industry is to increase in the future. Can our schools take care of this increased demand? I do not believe they can.

Not only should the capacity of the engineering schools as they exist to-day be greatly increased, but the number of such schools should also be increased. The question whether or not proper instruction in engineering can be given to large numbers should be thoroughly discussed. Can one thousand freshmen be given proper instruction in fundamentals which will lay a broad foundation for their later specialized training in applied science? Are there a sufficient number of trained teachers available for this work? If not, where in this country are we to secure such teachers? The answers to these questions, it seems to me, control industry in the United States.

COLLEGE NOTES.

University of Michigan Highway Engineering and Highway Transport.

PERIODS AND FEES FOR GRADUATE COURSES, DECEMBER 1, 1919, TO MARCH 19, 1920.

Civil Engineering 67. Highway Transport. Professor Blanchard. February 2 to 6, Monday to Friday, 1:30 to 4:30 P.M. 1 hour credit.

Civil Engineering 68. Bituminous Surfaces and Bituminous Pavements. Professor Blanchard. December 1 to 19, Mondays to Fridays, 1:30 to 4:30 P.M. 3 hours credit.

Civil Engineering 69. Highway Laboratory Research. Professor Bateman. January 5 to 23, Mondays to Fridays, 10 A.M. to 12 M. and 1:00 to 5:00 P.M. 2 to 3 hours credit, dependent upon a student's previous training in highway laboratory methods.

Civil Engineering 70. Highway Bridges. Professor Gram. February 9 to 20, Mondays and Fridays, 1:30 to 4:30 P.M. 2 hours credit.

Civil Engineering 71. Specifications and Contracts. Professor Riggs. February 9 to 20, Mondays to Fridays, 1:30 to 4:30 P.M. 2 hours credit.

Civil Engineering 72. Earth, Gravel and Broken Stone Roads. Professor Bateman. March 1 to 12, Mondays to Fridays, 1:30 to 4:30 P.M. 2 hours credit.

Civil Engineering 73. Cement-Concrete Pavements. Professor Blanchard. March 1 to 9, Mondays to Fridays, 1:30 to 4:30 P.M. 1 hour credit.

Civil Engineering 74. Brick Pavements. Professor Blanchard. March 11 to 19, Mondays to Fridays, 1:30 to 4:00 P.M. 1 hour credit.

Civil Engineering 75. Highway Engineering Seminar. Professor Blanchard. December 1 to March 19. 3 hours credit.

Fees: The fees for courses are based on the number of credit hours for each course. The fee for each credit hour is five dollars.

For further information pertaining to the short-period graduate courses, write to Arthur H. Blanchard, Professor of Highway Engineering, University of Michigan, Ann Arbor, Mich.

University of Southern California.—The first unit, an administration building to cost approximately half a million dollars, in the announced plans of the University of Southern California is in process of erection, the corner stone having been laid on Oct. 14.

The enrollment is the largest in the history of the institution, and approximates the total enrollment of last year which was more than four thousand. The enrollment in freshmen engineering courses is particularly heavy, being nearly twice that of last year.

The quarters of the civil engineering department have been remodeled and enlarged. Professor C. W. Lawrence is in charge.

The course in electrical engineering has been completely revised and a four year course in mechanical engineering added. These courses will be conducted on a modified coöperative plan under which a minimum of twenty-four weeks actual employment in commercial work will be prerequisite for graduation. This experience will be obtained during the summer vacations. The electric companies and manufacturing interests of Los Angeles are coöperating with the University in this work, which is in charge of Professor J. Fay Wilson. In connection with the revision of the courses, the laboratory equipment is being materially augmented.

Professor A. W. Nye, who was absent on war work during the past year, has returned and resumed charge of the department of physics.

COMMITTEE NO. 22, INTELLIGENCE TESTS.

You will be interested to know that the following engineering colleges are participating in the coöperative study of entrance tests:

- University of Akron.
- Alabama Polytechnic Institute.
- University of Alabama.
- University of Arkansas.
- University of California.
- Carnegie Inst. of Technology.
- Case School of Applied Science.
- Columbia University.
- Cornell University.
- The Drexel Institute.
- University of Idaho.
- Iowa State College, Ames, Ia.
- State Univ. of Iowa, Iowa City.
- Johns Hopkins University.
- Kan. State Agric. College.
- University of Kansas.
- Lafayette College.
- McGill University, Montreal.
- University of Maine.
- Marquette University.
- Michigan Agric. College.
- University of Michigan.
- University of Missouri (School of Mines).
- University of Missouri (School of Engineering).
- University of Montana.
- New Mexico College of Agric. & Mechanic Arts.
- New York University.
- University of Nevada.
- Ohio State University.
- Okla. Agric. & Mechanical College.
- University of Oklahoma.
- University of Penna.
- Purdue University.
- Rensselaer Polytechnic Institute.
- Rhode Island State College.
- Rose Polytechnic Institute.
- State Civil Service Commission of Ohio.
- Syracuse University.
- University of Texas.
- Throop College of Technology.
- Tufts College.
- Vanderbilt University.
- University of Vermont.
- University of Virginia.
- Warner & Swasey Co.
- University of Washington, Seattle.
- University of Wisconsin.
- Worcester Polytechnic Institute.

APPOINTMENTS BY THE PRESIDENT.

Professor H. E. T. Haultain, University of Toronto, has been appointed a member of Committee No. 18, Mining Engineering.

Professor H. H. Higbie and Dean M. E. Cooley were appointed to represent the Society at the Interprofessional Conference in Detroit, Mich., November 28–29.

President A. M. Greene, Jr., will represent the Society at the annual meeting of the American Society of Mechanical Engineers in New York, December 3–5.

NEW MEMBERS.

Allen, Frederick G., Assistant Professor of Electrical Engineering, Lafayette College, Easton, Pa.

Archibald, Leon, Instructor in Drawing and Descriptive Geometry, University of Minnesota, Minneapolis, Minn.

Calderwood, Jas. P., Professor of Steam and Gas Engineering, The Kansas State Agricultural College, Manhattan, Kans.

Campbell, Malcolm, M., Supervising Engineer, P. O. Box 385, Montreal.

Coler, Carl S., Manager, Educational Department, Westinghouse E. & M. Co., East Pittsburgh, Pa.

Drane, Walter H., Professor of Civil Engineering, University of Florida, Gainesville, Fla.

Fenton, Henry H., Assistant Professor of Electrical Engineering, Kansas State Agricultural College, Manhattan, Kans.

Gilbert, Earl B., Associate in Drawing, Technological High School, Atlanta, Ga.

Grandlienard, Edward T., Assistant Professor of Civil Engineering, University of Pennsylvania, Philadelphia, Pa.

McNeilly, Robert H., Associate Professor of Civil Engineering, Vanderbilt University, Nashville, Tenn.

Mack, Albert J., Instructor in Steam and Gas Engineering, Kansas State Agricultural College, Manhattan, Kans.

Bath, Edwin R., Instructor in Electrical Engineering, University of Pittsburgh, Pittsburgh, Pa.

Roark, Raymond J., Associate Professor of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.

Wilmot, Sydney, Assistant Professor of Civil Engineering, Brown University, Providence, R. I. .

SECTIONS OF THE SOCIETY.

The first section of the Society to be approved by the Council is the Pittsburgh Section. The organization meeting was held October 17, 1919, at the University Club, with twelve members of the Society present. This meeting was called by Dean W. E. Mott, Carnegie Institute of Technology, and Dean F. L. Bishop, University of Pittsburgh. Plans for 1919–20 were considered at this time and committees appointed. Professor P. M. Dysart of Schenley High School, was elected Chairman, and Professor L. H. Harris of the University of Pittsburgh, Secretary. The next meeting of this Section will be held Wednesday, December 3, at which time the following program will be offered:

General Topic: "What Are the Chief Defects in the Product of Engineering Schools?"

Speakers: B. F. Groat, Aluminum Company of America; D. F. Crawford, Locomotive Stoker Company; Carl S. Coler, Westinghouse E. & M. Company.

Special Discussion:

"What Defects Are Properly Chargeable to the Engineering Schools?" F. L. Bishop, Dean, School of Engineering, University of Pittsburgh.

"What Defects Can the School Hope to Remedy?" W. E. Mott, Dean, School of Applied Science, Carnegie Institute of Technology.

JOINT MEETING OF THE SOCIETY WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The Society for the Promotion of Engineering Education is an affiliated society of the American Association for the Advancement of Science and as such will hold a meeting with Section D, Engineering, on January 1, 1920. This meeting will be held in the Soldan High School, located at the corner of Union Boulevard and Kensington Avenue, 5300 west.

The meeting of the Association will be held from December 29, 1919, to January 3, 1920. The meetings of Section D, Engineering, will be held December 31, 1919, and January 1, 1920. Dean A. S. Langsdorf, of Washington University, will have charge of the arrangements for the meetings of Section D. President Ira N. Hollis, Worcester Polytechnic Institute is Chairman of Section D, and Dean F. L. Bishop, University of Pittsburgh, Secretary. An interesting program has been arranged.

BULLETIN

OF THE

Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee:

Arthur M. Greene, Jr., John F. Hayford, F. L. Bishop, *Editor*.

Address all communications to the Editor, University of Pittsburgh, Pittsburgh, Pa.

VOL. X LANCASTER, PA., JANUARY, 1920 No. 5

TABLE OF CONTENTS.

Business Training in Mining and Metallurgical Curricula. L. E. Young 152
College Shop Instruction. F. G. Higbie 169
Preliminary Report of Committee No. 22, Intelligence Tests 175
Editorial 177
College Notes 178
Pittsburgh Section 182
Book Review 183
Mathematical Committee 183

BUSINESS TRAINING IN MINING AND METALLURGICAL CURRICULA.*

BY L. E. YOUNG,

Manager, Steam Heating Utility, Union Electric Light & Power Company, St. Louis, Mo.

During the past few years there has been considerable discussion of the value of training in economics for students in engineering. There seems to be a question in the minds of some faculty members as to the advisability of including such subjects as economics, accounting, business law, and business organization in an undergraduate curriculum in mining or metallurgy.

Needs for Business Training.

The most recent catalogue of an institution of first rank in describing the curriculum in mining engineering states that

> The object of the course is primarily to train a student for practice in the field of mining engineering. It is designed to give him the thorough fundamental training of an engineer and a breadth of education that will enable him readily to undertake work in the various lines of engineering which frequently present themselves to one of his profession. The course, therefore, when completed, places the graduate in the path of a large number of opportunities. Not only will he have had sufficient practice and training to enter upon the field of mining, but he can also engage in work in which geology and metallurgy play an important part, as well as in engineering projects related thereto.
>
> The principal objects in view are that the student upon graduation, may be enabled: first, to make and plat surface and mine surveys, and to map the topography and geology of a district; second, to analyze, value and treat minerals found upon a property, to report upon them, and to analyze metallurgical products; third, to make drawings and designs to meet the requirements of given cases; fourth, to take a subordinate position as an engineer in connection with any of the previously indicated lines of work.

---

* Presented at National Conference of Schools of Mines of the American Mining Congress, St. Louis, Mo., Nov. 17–22, 1919.

BUSINESS TRAINING.

In order that the young engineer may advance in his profession and in the course of years fill more than a subordinate position as a surveyor, draftsman, designer, chemist, or assayer, he must acquaint himself with many aspects of the business of mining; he must know something of the general methods and practice in the business world and, as well, the more or less localized procedure of the mining district or districts in which he is engaged. The American mining engineer has been called upon to undertake varied problems, the success of many of which has depended more upon a combined knowledge of mining technology and business than upon mining technology alone.

The other divisions of engineering are recognizing the demand for breadth of training, and it seems unnecessary to present at length reasons for including courses in economics and business in the mining and metallurgical curricula. If the reputation of an educational institution is that it develops simply good assayers, chemists, draftsmen, and surveyors and those who are responsible for the course of study in the institution are satisfied with such a finished product—with graduates who are looking no higher than the subordinate positions in large organizations—then let us continue by the well-developed and accepted curricula to produce men of such caliber and men with such a vision of their place and opportunity in the profession. Honorable as such branches of technology are as a life work, there are much more important and at the same time more lucrative positions available for the men who, in addition to having the training along the previously mentioned technical lines, have acquainted themselves with the fundamental principles of economics and business. Granting that many of the men may not have inherent qualities fitting them for leadership of the highest type, it must still be conceded that in the course of time every college trained man should take some part in solving the complex problems arising in the employment of labor, the development of mining communities, the financing of private and public enterprises, etc.

Upon graduation from mining curricula some men find employment with large corporations and may be assigned to work in some special line; others go to the small mines where their work is varied—they may be assayer, bookkeeper, surveyor, time clerk, and supply clerk, all in one person. In such a humble position a general knowledge of business procedure is invaluable. But wherever the young man may go, if he has had some training in economics and business, he has a great advantage. The chief questions are: How, when, and where can he get such training without serious interference with his technical education?

ENGINEERING CURRICULA AND THE S. P. E. E.

For several years the Society for the Promotion of Engineering Education has been studying engineering curricula. The Committee on Economics has secured and published data on economics courses included in civil, electrical, and mechanical engineering curricula in forty-two institutions (*Proceedings S. P. E. E.*, 1918, Vol. XXVI, p. 219). Of twenty-three institutions requiring economics, the maximum number of credit hours was twelve which was required by only one institution; a minimum of two was required by six institutions; while eight institutions of the total of twenty-three required three hours.

The Committee serving in the year 1917 recommended to their successors of the Committee of 1918 that they prepare a definite scope and content of courses based on the following topics:

1. A preliminary study in commercial geography and industrial history.
2. Fundamental course in the principles of economics.
3. Application of these principles to engineering.
4. Lessons upon special application in detail engineering work.

The Committee appointed in 1918 undertook to follow the suggestions of the Commitee of 1917. The Committee distinguished between "economics" and "economy of construction" as follows:

> The term economics is taken to mean "The science of wealth" and to deal with matters pertaining to the consumption, production, exchange and distribution of the world's wealth as a more or less abstract social science. (*Proceedings S. P. E. E.*, 1918, Vol. XXVI, p. 220.) Economy of construction on the other hand should cover those principles of design and construction which accomplish desired results with the minimum expenditure of money all factors being considered, and is founded primarily upon unit costs, maintenance and life of structures, and cost of operation.

The Committee of 1918 recommended "that an outline course on economics, but no more, be required of all engineering students. Engineering has chiefly an economic aspect, that is, it has to do with the production, exchange, and distribution of wealth, and the student should become familiar with those general factors which are the framework of society's economic organization and should be led to see how engineering operations are related to them. He should understand that an engineer possesses a training that has economic value and that he will be able to 'market his wares' only as he comprehends the economic and commercial organization of society from both the theoretical and practical viewpoints."

The Committee recommended that the amount of time devoted to the formal study of economics be not more than three semester credit hours and that the subject matter be similar to the treatment in any standard text on "economics" with frequent illustrations from actual facts of commercial geography and industrial history. Recommendation was made that "special subjects in the economics group, such as accounting, labor problems, public and corporation finance, taxation, money and banking, and others, while possessing much value as information courses, do not seem to deserve a place in the engineering curriculum owing to the already crowded condition of the latter and also because an intelligent technical graduate can read books on any of these subjects understandingly without the aid of an instructor." (Idem, p. 222.)

The Committee directed special attention to the mode of administering the course in economics for engineering students, owing to the apathy of the latter toward this subject, and recommended that the subject of economics be taught by a professor of economics having a broad education and experience in corporation business, a man to whom the subject is alive and possesses a vital connection with the commercial world.

TOTAL HOURS REQUIRED PER WEEK.

Professor Breckenridge of Yale University recently secured the opinion of teachers in departments of mechanical engineering as to the total time to be spent in class, drawing, laboratory, and study. Of eighteen replies the minimum number suggested was forty-six and the maximum fifty-four. The average was fifty and five-tenths hours. (BULLETIN S. P. E. E., 1919, Vol. IX, p. 415.)

Most of the curricula in mining and metallurgy now offered require not less than the average number of hours reported by Professor Breckenridge. On the basis of the "Study of Engineering Education" made by Dr. Mann, a committee for the Society for the Promotion of Engineering recommended

> That the schedules for engineering students should call for not more than 48 work hours per week (including recitation, laboratory, field work and home preparation), this time to be divided among not more than 5 subjects which require preparation outside of class exercise.
>
> That all engineering students should be required to pursue courses which will prepare them for administrative duties and for responsible and effective citizenship.

THE REPORT OF DR. MANN.

Dr. Mann in his report refers to the widespread agreement among professional engineers

> That considerable attention should be paid to humanistic studies like English, economics, sociology, and history, not merely because of their practical value to the engineer but also because of their broad human values; and that the young engineer should have some conception of business management and of the most intelligent methods of organizing and controlling men.

> The difficulty in present school practice evidently lies in the exclusion from the technical work of all consideration of the questions of human values and costs; and, conversely, the isolation of the humanistic studies from all technical interest. . . . And after all, the ultimate control of all engineering projects, as of all activities, is vested in some man's decision that the game is really worth while; and this control is likely to be more salutary, the more completely the man who decides comprehends the full import of the values and costs involved.

The report of Dr. Mann, published in 1918, has caused many engineering educators to think seriously about the real function of the institution with which they are associated, and many beneficial results of Dr. Mann's work are evident.

CURRICULA IN COMMERCIAL ENGINEERING.

The Bureau of Education has called several conferences to consider the development of courses in "Commercial Engineering." Reports of the suggestions made at these conferences have been published, the most important of which are as follows:

> 1. That from 12 to 18 semester hours be required of all engineering students covering the following subjects: General economics, cost accounting, business organization, and business law.
> 2. That for engineering schools desiring to extend further the commercial or industrial aspects of engineering, the following subjects are recommended as electives: Labor and employment, corporation management and finance, statistics, marketing, scientific management, psychology, transportation, and political science.
> 3. That the economic phases of engineering be emphasized in engineering institutions wherever possible.

A brief review of the status of curricula in Commercial Engineering and Business Administration is given in the BULLETIN of the Society for the Promotion of Engineering Education of June, 1919. There have been two new types of curricula recognized, namely (1) Commercial Engineering or Engineering Administration, which is planned to be a course of study leading to an engineering degree and which includes enough technical subjects to classify it as properly an engineering curriculum; and (2) Business Administration, which is planned to be a course of study leading to a degree in business or commerce and which is meant to be a business administration curriculum although it contains a number of elementary engineering courses as well as courses in mathematics, physics, and applied science. Both types of curricula are planned to train men for administrative work, the former containing the more engineering.

It may be well to keep these developments in business and engineering administration curricula in mind in considering the possibilities of mine administration curricula.

In commenting on this movement toward the development of Commercial Engineering, the Committee on Economics of the Society for the Promotion of Engineering Education called attention to the "desirability of recognizing the abnormal state of industrial affairs in connection with the teaching of economics" and urged "the importance of laying emphasis on sound economic doctrine. The teaching of sound economic doctrine in colleges will be one means of hastening the inevitable return of the economic pendulum to the mean position which is so necessary for further industrial development."

TYPES OF MINING CURRICULA.

Any investigation of the feasibility of including training in economics and business subjects in mining and metallurgical curricula must recognize the fact that there are several types of institutions offering curricula leading to degrees in mining engineering. Obviously it will be impractical to propose any group of subjects which can be adopted uniformly in all institutions, and all that can be hoped for is the presentation of general suggestions which may be adapted to a number of the undergraduate curricula.

In considering the problems arising in connection with the curricula, control of courses, teaching staff available, etc., the institutions offering instruction in mining and metallurgy may be grouped somewhat as follows:

1. Schools or colleges existing as independent institutions and primarily for instruction in mining and metallurgy and which offer three or four years work leading to an undergraduate degree. Institutions of this type have previously limited instruction to engineering and science and the faculties have generally not included men properly qualified to offer courses in economics (as defined by the Committee on Economics of the Society for the Promotion of Engineering Education), accounting, and business organization.
2. Colleges or departments in institutions such as colleges of agriculture and mechanic arts. Usually the faculty of such an institution includes men qualified to give the business courses but in many instances the staff is not large enough to give the mining students the special attention required, so that if the mining students are enrolled in the courses offered they are not likely to be benefited greatly by the work.
3. Colleges or departments in institutions in which a college of commerce is organized. Usually the teaching staff of a college of commerce is large enough so that mining students may be segregated from the general classes taking commerce subjects and given the particular training desired.
4. Colleges offering mining or metallurgical curricula as graduate work only. These may specify that certain courses in economics and business are required for admission either to the entire curriculum or to certain advanced courses; in this way men come into the advanced courses with a broader viewpoint and a knowledge of economics, business practice and organization.

OTHER METHODS OF SECURING BUSINESS TRAINING.

The proposal that economics and business subjects be required as prerequisites for admission to mining and metallurgical curricula suggests that there are several ways in which such courses or training may be given other than in the undergraduate curricula. Briefly, they are as follows:

1. High-school or business-college courses in bookkeeping, economics, and business practice taken prior to entering college. Certain fundamentals may be secured in this way and undoubtedly, if there is no opportunity to include courses in economics, etc., in the college or university curricula, the student should be advised to elect substantial business courses in the high school.
2. College courses in economics and business to be undertaken after completion of a mining or metallurgical curriculum.

3. Training by means of extension or correspondence courses after graduation from a mining or metallurgical curriculum.
4. Independent reading and study without supervision.

Each of these plans has some advantages and, at times, may be the only means of training feasible.

PRESENT STATUS OF MINING CURRICULA.

Information is available regarding forty institutions offering curricula leading to degrees in mining or metallurgy. Several other institutions offer some work of college grade but not a complete four-year curriculum. Of the forty institutions referred to, thirty-three now have members of the faculty teaching economics as previously defined, and another expects to appoint a professor of economics as soon as a qualified man can be secured. The six institutions not having chairs of economics are colleges of applied science or mining and offer practically no humanistic subjects except English and foreign languages.

Only thirteen institutions include economics in the mining and metallurgical curricula as a required subject while seven others permit economics to be taken as an elective. Of the thirty-three institutions equipped to teach economics, there are therefore only twenty institutions offering instruction in this field of mining students. Of the thirty-three institutions one requires at least two years' college work before matriculation and as economics may be elected, the total number of institutions in which economics is either an elective or required subject is in fact twenty-one.

Several other institutions are now proposing courses in economics for next year or advise that, upon approval of the faculty, economic subjects may be substituted for certain courses now required or for technical electives.

ECONOMICS AND BUSINESS COURSES NOW REQUIRED.

Inasmuch as the total number of institutions now requiring economics and business subjects is only thirteen, it may be profitable to make a rapid survey of the subjects, hours, and content of the courses described.

Number 1 (a state university) requires a three-hour course in economics during the third quarter of the senior year. In addition there is a three-hour course in mine management given by a member of the mining faculty, and a two-hour course in mining law by a lawyer.

Number 2 (a college of agriculture and mechanic arts) requires a three-hour course in economics in the first semester of the senior year, followed by a three-hour course in either corporations, money and banking, or transportation problems. There are also courses in mining law and mine management.

Number 3 (a state university) requires a three-hour course in economics the first semester of the senior year, followed by a two-hour course in industrial administration, the latter being taught by a member of the engineering faculty. The mining faculty gives a one-hour course in mine administration and a two-hour course in mine examination and reports.

Number 4 (a school of technology) requires a three-hour course in economics throughout the junior year. The mining courses present the business, sociological and legal phases of mining.

Number 5 (a school of mines) requires a three-hour course in economics in both semesters of the senior year. The professor of mining gives a one-hour course in mine management during two semesters and a one-hour course in mining law for one semester.

Number 6 (a college of agriculture and mechanic arts) requires a three-hour course in economics during the first semester of the senior year, followed by a three-hour course in labor problems. The mining department gives a two-hour course in mine administration and examination, a one-hour course in economics of mining, and a one-hour course in mining law.

Number 7 (a university) requires a two-hour course in economics, followed by a two-hour course in labor problems. Most of the students have also been required to take a two-hour course in corporation finance, a two-hour course in modern industries, and a two-hour course in accounting. The mining department has given a five-hour course one semester in economics applied to mining. If a proposed curriculum is approved, business and economic subjects will be given for five-hours throughout the junior year and probably at least one-half of the entire time of the senior year will be devoted to business courses.

Number 8 (a university) requires economics two hours during the first semester of the sophomore year, followed in sequence by accounting (2 hours), business law (3 hours), finance (2 hours), industrial management (2 hours), and contracts and specifications (2 hours). All of these subjects except the last are taught by the economics department. The mining department gives courses in mine administration, valuation, etc.

Number 9 (a state university) has not required economics but a new curriculum now includes economics (three semester hours); money, credits, and banking (three hours); business law (three hours); and accounting (two hours). These subjects are to be required for all engineering students. The mining department now gives a two-hour course in mine management.

Number 10 (a school of technology) proposes to train men for the position of mine superintendents and managers. The curriculum includes twenty commercial and non-technical topics, including economics, contracts, mining law, commercial law, bookkeeping, cost accounting, corporation finance, banking and insurance, compensation insurance, labor problems, industrial management, transportation, advertising and salesmanship, and applied psychology.

Number 11 (a university) requires four semesters of work in economics and business, as follows: Economics, first semester, junior year, three hours; business finance, second semester, junior year, three hours; and accounting, both semesters of the senior year, three hours. Courses in mine management, mine accounts, and mining law are included in a graduate curriculum. The mining law is taught by a member of the law faculty.

Number 12 (a state university) requires a course in economics extending through both semesters of the senior year. The mining department gives a two-hour course in mine management and accounts. All of the other engineering students take additional courses in engineering economics (one hour) and engineering jurisprudence (two hours) taught by a member of the engineering faculty.

Number 13 (a school of mines) requires a three-hour course in economics during the second semester of the junior year. The mining department gives a two-hour course in mine accounting and a one-hour course in mining law for one semester.

MINING COURSES WITH ECONOMIC ASPECTS.

A number of institutions, in addition to those cited above, offer and require courses in mine examination and valuation, mining law, and mine management. A few give special attention to labor problems in the mining industry. One institution includes mine examination and reports and economics of mining as required subjects in the graduate curriculum.

It is no reflection upon the men giving these courses to say that in general these courses may be classed as courses similar to those grouped by the Committee on Economics of the Society for the Promotion of Engineering Education as "economics of construction" and not truly courses in "economics."

Several institutions now offer courses in mine accounts that are entirely adequate for an engineer who does not expect to become an accountant; most of the other mining curricula would be strengthened by the addition of a general course in accounting.

BUSINESS COURSES SUGGESTED.

In the opinion of the writer, provision should be made for instruction in the following subjects, all of which should be given three hours a semester if possible:

BUSINESS TRAINING.

1. Principles of economics as outlined in any standard text, giving special attention to illustrative material which should be selected carefully. The method of teaching should be a combination of lectures, recitations, discussions, and assigned problems. The course may well come in the first semester of the junior year.

2. Business organization and corporation finance. This course may be given either directly after the course in economics or may follow the course in business law and accounting. It should include a general survey of the types of business organization, the incorporation of companies, financial problems in connection with corporate organization, and the organization of mines and mining companies from an operating standpoint.

3. Business law. If other courses have not presented the fundamentals of mining law, these fundamentals may be included in this course, but the major portion of the time assigned to this course should be given to the presentation of the fundamental features of the law of business. Among the most important subjects to be considered are contracts, real property, agency, sales, and negotiable instruments. In many engineering institutions courses are now given in contracts and specifications. The course in business law may properly precede a course on engineering specifications and the writing of engineering contracts as taught by an engineering instructor.

The course in business law will probably be considered by the students as a failure unless the illustrations used have an industrial background. While the case method as used in the law schools cannot be followed closely owing to the fact that it has been developed with the idea of presenting legal procedure as well as rules of law, the use of carefully selected cases as illustrations in conjunction with a standard text on business law is highly desirable. Experience has shown that good results can be secured in teaching business law to engineering students if carefully selected cases are assigned occasionally.

4. Accounting. Students should be advised to take bookkeeping in high school. The college course should include an outline of accounting and bookkeeping; double entry; fundamental accounts and books. The fundamentals of cost accounting should be presented and the preparation and analysis of financial statements of mining corporations.

The foregoing suggestions can be modified to meet the local problems of various institutions. Several institutions are now giving courses of the nature and extent suggested while others are giving more courses and much more time than the writer suggests.

DIFFICULTIES.

Among the difficulties to be encountered in introducing such courses are (1) the prejudice of the students and some members of the faculty against courses in economics; (2) the present crowded condition of the curricula, resulting in the students neglecting non-technical subjects for technical courses; (3) the fact that several institutions have not previously employed a teacher of economics; and (4) the scarcity of qualified teachers of economics, particularly those who have sufficient knowledge of industry and of the engineering profession to appreciate the viewpoint of the engineer.

In the institutions which now provide instruction in economics, but in which the mining curricula do not include economics as a required subject, the objection to the addition of economics is generally that no time is available or that the economics faculty will not provide a proper course for engineers. The latter objection may be overcome by coöperating with the economics faculty and preparing a detailed outline of the courses desired, based upon the experience of the institutions in which economics courses for engineers have been established successfully.

The objection has been raised that the mining curricula are so crowded that the addition of non-technical courses will result in the elimination of essential engineering work. Two plans may be suggested to meet this objection, as follows:

1. Provide an undergraduate curriculum to be known as the "mine administration curriculum"; include in it the economics and business courses desired; and for this curriculum give a Bachelor of Science degree but not in engineering. In a number of institutions this is not feasible, as the degrees conferred are exclusively in engineering.

2. Add a fifth year, including some graduate work in mining but largely courses in economics and business. The demand for a four-year instead of a five-year course will probably prevent the successful development of the latter plan in many institutions.

Institutions of the first rank have been able to provide as much as twelve semester hours time for economic subjects. It may not be advisable to introduce more than six hours when the new courses are inaugurated. But before the entire proposal to introduce economics courses is dismissed on the ground that no time is available, the following questions should be asked searchingly by each administrative officer in regard to his own institution:

1. Are the students now matriculated properly qualified to do collegiate work?
2. Is the undergraduate instruction given effectively?
3. Is the student's time taken up with routine, details, or courses consisting chiefly of informational matter which can be read independently after graduation?

As thirteen institutions have endorsed the plan of giving instruction in economics and business and have found it feasible to adjust the curricula to permit such courses to be given, it is no longer logical to dismiss the problem by saying "it cannot be done" or "it will not work." With students properly qualified to enter college and with a competent faculty, it has worked.

New Economic Problems.

In conclusion, it seems appropriate in urging the timeliness of training in economics for mining students to refer to the various broad economic problems being discussed in the United States and Europe, among which is the nationalization of mines. Serious consideration is being given to this matter in Great Britain, and whether or not we favor or oppose the plan being discussed, it is important that the men who are to be the leaders in the mining profession shall be able to think clearly upon such momentous questions.

On August 18, 1919, the Prime Minister addressed the British Parliament regarding the report of the Coal Commission as follows:

> We have accepted the principles of unification and reorganization, and we think that even the owners realize that there is a very great case

made out for that, because you have the waste which is due to a large number of different enterprises running in the same area under different management—waste of power, waste in management, waste in distribution. There is also undoubtedly a case to be made out for giving the miners a greater interest and voice in the working conditions which affect them. Therefore we make this recommendation—that in view of the fact that the living and livelihood of the miners depend on the way the mines are worked, means should be devised for securing their co-operation in shaping the general conditions of the industry without interfering with the executive control of individual mines.

Now I come to our recommendation with regard to unification. It is that the industry shall be so organized as to reduce to a minimum the expense of management and working charges, and with this end in view the country should be divided into defined areas, in each of which the amalgamation of neighboring mines should be undertaken within a limited period, say two years. and that the workers in and about the mines should have directors representing them in the body controlling the area group to which they belong.

The government proposes to prepare a scheme and submit it to Parliament with the least possible delay, by which the minerals should be purchased by the state and funds raised for the purpose of promoting schemes for the social improvement and amelioration of the conditions and amenities of life in the mining villages. The state should not purchase the business of mines.

The plan proposed was not acceptable to trade unionists in general, and by a vote of 4,478,000 to 77,000 a resolution was carried which in effect demands the nationalization of the coal mines. The nationalization of coal mines has become one of the leading questions of the day in England.

If nationalization of mines becomes a fact in England, it is not unreasonable to expect there will be a serious consideration of the same subject in America, and if it becomes a critical question here, the mining profession must be ready to consider it on broad lines.

The time appears to be at hand when the mining engineer must take a more prominent part in the affairs of the nation; he can do this much more effectively if he has a broad training and is qualified to consider the fundamental economic problems of the mining industry and of the nation. Collegiate courses as proposed will aid materially in furnishing this training.

The responsibility of the faculty in this matter cannot be overlooked. A recent publication of the engineering school of a leading university contains the following statement:

> The aims which have served as controlling considerations in the selection of the teaching staff and in the laying out of the instruction of the school are: to train men to think; to lay a broad and deep foundation with an outline of the superstructure which can be filled in gradually from the training and observation which come from practical experience; to encourage the student so thoroughly to understand each problem, that he can apply the same principles intelligently to the solution of entirely different kinds of problems, and finally to train men to be good citizens as well as good engineers.

As the faculty is responsible for the breadth and depth of foundation and the outline of the superstructure, the subject of training in economics and business should be considered with the care and the thought which its importance warrants.

COLLEGE SHOP INSTRUCTION.

BY F. G. HIGBEE,

Professor and Head, Department of Descriptive Geometry and Drawing, State University of Iowa.

What is the purpose of the college shop? Just what function does it perform in the educational process of which it is a part? And how is the college shop operated? These are questions which may be answered in as many ways as there are college shops; there seems to be no general agreement concerning the purpose, the function, and the operation of this important feature of engineering education. It would seem, therefore, that it might be worth while to answer these questions without regard to conditions as they may exist and to set down what a college shop should aim to accomplish and how it may do this merely for the sake of establishing an ideal which might be used as a gauge for college shop instruction.

Broadly speaking the purpose of the college shop should be to provide each student of engineering with the opportunity to study at close range the business of manufacturing, including all of the elements which form a part of the process of production. In other words the college shop should be a manufacturing organization complete in every detail wherein a student may have the opportunity for first hand study of operating conditions and the experience of being a unit in each department of such an organization, always of course under proper instruction and close supervision.

The organization and equipment of a college shop to operate under such conditions is neither a difficult nor an expensive matter, but there are certain prime essentials which must be kept constantly in the foreground if the plan is to be a success. The first and most important of these essentials is the fact that even though the shop is a manufacturing and producing organization it is, nevertheless, a part of an educational process and that, therefore, its efficiency is not to be measured in terms of production, as one would measure a commercial establishment, but rather in terms of the opportunities it affords students for learning the methods by which production may be accomplished. This condition necessarily effects shop management to a certain degree, but the shop should be organized as near as possible on a commercial basis. Another essential of first importance is the elimination, to a much greater degree than is usually found in college shops, of exercise work and the substitution therefore of work on actual parts of some article of commercial use. This means that the shop must be manufacturing some article whose several parts will afford the variety of operations necessary for a complete and comprehensive experience in production, and an article which the student may follow through the organization from drafting room to shipping floor. This is essential if the idea of shop management and production is to be completely carried out, and while it is not difficult to find such an article it must be selected with some care in order to provide the proper variety of work and to avoid the danger of attempting something beyond the capacity of a college shop.

It may seem that the two ideas of conducting a college shop on a commercial basis and at the same time making it a part of an educational scheme are directly opposed, and in a measure they are. If the educational feature of this plan is to predominate the commercial feature must, of course, be subordinate and, in consequence, the shop can not be expected to produce according to commercial standards nor to operate at a profit. But this is not necessary. Since educational institutions are not conducted for profit it will be possible to operate the college shop just as thought it were producing at a profit. And even though it will doubtless operate at a loss it is not improbable that the ''educational profit'' per student will be materially increased.

Let it be assumed for the sake of demonstrating the possibilities of this plan of shop education, and not because the arrangement is necessarily the best, that the shop organization is divided into four general departments of instruction; the engineering department, the production department, the assembly department, and the business department. The form of the organization and the function of each department may be varied to suit local conditions if need be; the essential part of this plan is not the form, it consists in having organization and keeping it as efficient as possible both as to production and to teaching.

The work of the engineering department should include the work now usually done in colleges by the department of drawing and design. There is no especial need to reorganize any college in order to carry out this plan of shop instruction, but there must be coördination and coöperation. In addition to furnishing the college shop with complete drawings of the article for production, including the drawings for all tools, jigs, and fixtures, it should be the function of this department also to study and plan the progress of the work through the shop and to furnish instruction cards for the workmen. It will be evident, therefore, that from an educational standpoint this department must teach drafting and design, tool design, drafting-room management, including the filing and indexing of drawings and information, as well as to teach the functions of a planning department and its proper operation. It is not to be assumed that a student is to take the entire work of such a department in one dose; on the contrary he should pass back and forth from one department to another in that order which will best promote his progress. For example, after he has learned to make a shop drawing he should enter the production department to learn how it is used, and after acquiring some shop experience he might reënter the engineering department to take up some other work in that phase of the development of the manufacturing process.

The advantages of such an arrangement are more or less obvious; in no better way can a student be made to appreciate what is required of a drawing and what it is for, of how shop considerations effect design, and of what the functions of an engineering department are. The fact, too, that he is a part of a shop organization is an education in itself.

The producing department may be organized without changing the arrangement which is common in most college shops. There should be of course a pattern shop, a foundry, a forge shop, a machine shop, and a tool room. The student should follow the progress of a number of parts through each of these shops in turn and in addition perhaps study the production of some special pieces designed to bring out special operations not included in the manufacture of the regular product.

As a general thing college shops devote too much time to teaching operation with the result that the student gets the notion that he is "learning to run a lathe" or "to make a pattern." If time were available the acquisition of such ability would be an extremely desirable thing for him both practically and educationally, but with the limited amount of time allowed for shop education the acquiring of the ability to operate this or that machine or to perform this or that operation in shop production is a secondary consideration. The student is in the shop primarily to learn how things are done rather than to acquire the ability to do them himself. He should be primarily an observer and secondarily a "doer." To learn production with this ideal prevailing will require a method of teaching not usually found in college shops.

Each department of the shop should be in charge of a foreman *who is also a teacher,* and under him there should be at work enough expert workmen to illustrate all phases of the work he is teaching. The student then should enter each of these departments in turn as an observer; in his possession he should have a set of question sheets designed to cover the entire range of operations of machines and tools in that department, and it should be his business to find out, with the assistance of the foreman and his workmen, the answers to these questions. When this has been satisfactorily done as much time as can be allowed—and the more time the better—

should be devoted to the learning of the trade under the guidance of the workmen. It must be apparent that under such an arrangement the student may acquire in a short time a wide range of information and an intimate knowledge of shop production. The value of all of this depends absolutely upon the comprehensiveness of the question sheets, the thoroughness with which it is required they should be grasped, the searching character of the investigation demanded, and the amount of assigned reading.

Such a plan of operation puts the college shop on a producing basis independent of student workmen, yet at the same time it affords the opportunity for close observation of work being done under commercial conditions by expert workmen. It may be justly argued that this method of teaching allows very little time for the student to learn to perform shop operations himself; while this may doubtless be the case it is to be remembered that the function of the college shop is not to train operatives but to teach the larger phases of shop production; the function of each machine and tool, of each department, of each unit in the shop organization, the possibilities and limitations of materials, of machines, and of men, and the relation of all of these to the general process of manufacturing.

Having studied production the student should now take up some features of shop training often neglected in college shops. These have been grouped for convenience under the assembly department, but it is not important to keep them there. Indeed, it may be found in some cases to shift some of them to other departments would result in a better arrangement. In this department the student should study the proper methods of inspection of parts, the assembly of parts into the complete machine and of course as much time as possible should be devoted to actual practice of these methods. Following inspection and assembly such matters as painting and finishing should be taken up, the testing of the machine, and crating and packing for shipment. There should also be an opportunity to study the purpose and operation of the stock room for the storage of raw materials, patterns, and finished parts and their issuance to the shop. These are operations of minor importance in shop production which may account for the fact that they are usually neglected, but nevertheless they are important enough to warrant some study if the student is to acquire a complete knowledge of production.

The study of business management should be included in shop education as well as the study of production. It is the lack of such information that causes employers sometimes to stand amazed at the ignorance of the college graduate! The purchasing of supplies, the method of conducting advertising and sales, accounting, and shop organization are the essential things to be studied, and after an appreciation of their importance has been impressed upon the student by his experiences in the shop these important features of management should be welcomed by the student as a part of shop training.

In conclusion it may be seen then that the purpose, the function, and the operation of the college shop should be established on a basis designed to provide a broad training in the business of manufacturing, to teach the "why" rather than the "how" of shop production, and to afford the opportunity of acquiring this training and experience in a laboratory of shop training conducted on a commercial basis. Necessarily the description of such college shop and its operation here given is very general, but from even this bare outline it should be clear that such a shop is not an impossibility. It should also be apparent that the plan of instruction here outlined offers a solution for that lack of knowledge so often encountered among technical men of the thousand and one small things in shop management of which the great whole is built.

PRELIMINARY REPORT OF COMMITTEE NO. 22, INTELLIGENCE TESTS.

The six examinations that were prepared by Committee No. 22 on intelligence tests have been given to a large number of engineering colleges represented in the Society. Approximately ten thousand engineering freshmen have taken these tests and the Committee is now receiving data from the participating colleges on the test scores. We are now engaged in the task of preparing norms of performance on each of the colleges by which the standing of each student in each test may be determined relative to his classmates or relative to engineering freshmen in general. Later other data sheets will be sent to the participating colleges for recording the scholastic standing. These will be checked against the test scores by correlation statistics. The same procedure will be applied with the high-school scholarship and with entrance examinations in an effort to determine the predictive value of intelligence tests, the special examinations, the college entrance examination, and high-school scholarship.

One of the most important tasks of the Committee is to ascertain whether or not we can reduce the number of failures by properly selected criteria for admission without reducing the number of students admitted to each college. For this reason it is highly desirable that each participating college keep a close record of the reason for withdrawal of all students that drop out during the college course. This will be the subject of a special inquiry and the predictive value of each entrance criterion will be determined with respect to the failures.

The Committee is also anxious to enlist the coöperation of a large number of representative secondary schools and for this reason four thousand sets of test papers have been printed. The members of the Society will assist considerably in this investigation by calling the attention of representative secondary schools to the fact that these test papers are now available for high-school seniors.

C. R. DOOLEY,
D. C. JACKSON,
W. T. MAGRUDER,
ANSON MARSTON,
L. L. THURSTONE, *Chairman.*

EDITORIAL.

How Are We to Recruit the Teaching Profession?—The demand for engineers and especially men of experience with specialized knowledge in industry, has increased enormously since 1914. This is, of course, pleasing to all interested in the promotion of engineering education but there is, however, one effect which is a matter of serious concern to all, that is the draft which has been made on engineers engaged in teaching, an increasing number of whom are leaving the teaching profession to accept more lucrative positions in commercial life. Most of these men prefer teaching; they are interested in it and are successful, but the compensation allowed teachers has decreased relatively so much that many have been unable to refuse the offers and especially opportunities of commercial life. Another factor which produces the same effect is the increase in the freshman class of nearly every engineering school in the country. This means if the attendance in the freshman class becomes normal in the next two years, a very decided increase in the attendance at engineering schools. These two factors are causing a dearth of trained teachers in engineering schools. The immediate effect of this shortage of teachers has been the creating in many schools of large sections in all subjects. The teaching staff must be materially increased if we are to retain sections of a size which can be taught efficiently or even taught at all. The Secretary of this Society has received a large number of notices of vacant positions not only of the lower grades, but in all positions in engineering schools.

The situation is extremely critical and some organized effort should be made to increase the teaching staff and provide properly trained teachers of engineering subjects. Of course, one of the controlling factors in the whole situation is the matter of salaries. This, however, seems to be slowly but surely adjusting itself and we may expect in the next year or two, to find teachers' salaries commensurate with those paid for commercial work. This, however, is not the controlling factor. Greater opportunities for investigation, study and writing must be provided for the engineer engaged in teaching. This is one of the reasons why in the past so many good men have entered the teaching profession. Today another factor is entering, namely, a necessity for all teachers of engineering to have at least a year of practical engineering work before becoming teachers. It is no longer feasible or practical to select a man having high academic records from the senior class, appoint him as an assistant, have him devote his entire time to academic instruction and gradually promote him in the teaching profession. The students of our engineering schools no longer take kindly to this type of instruction. Many of them have had experience themselves and demand greater experience on the part of the engineering teacher.

COLLEGE NOTES.

University of Illinois.—*Registration of Students.*—The number of undergraduate students registered in the College of Engineering of the University of Illinois on November 1, 1919, is as follows:

Architecture	127
Architectural Engineering	147
Ceramic Engineering	47
Civil Engineering	326
Electrical Engineering	445
General Engineering Physics	2
Mechanical Engineering	515
Mining Engineering	58
Municipal and Sanitary Engineering	11
Railway Engineering	36
Total	1,714

Engineering Investigation of National Importance to be Carried on by the Illinois Engineering Experiment Station.—

In 1915 Mr. Ambrose Swasey, of Cleveland, Ohio, a member of the celebrated firm of Warner and Swasey, makers of mounts for large telescopes and of machine tools of the highest grade, gave a fund of several hundred thousand dollars, the income of which was to be used "for the advancement of arts and sciences connected with engineering and for the benefit of mankind." The income of this fund has been given in small amounts to various engineering investigations by the Engineering Foundation, which is the body organized to administer the fund. Last spring the governing board of the Engineering foundation (of which Dr. W. F. M. Goss, former dean of the college of engineering is a member) decided that it would be advisable to give the bulk of the income for the support of one major research, and they asked the National Research Council, a body organized to coördinate war-time scientific research, to recommend some piece of research to be supported.

During the war the National Research Council had organized a committee to study the failure of crank shafts of airplane engines, of welded ship plates, and of other metal parts of machines under the repeated loads applied to them in service. The Committee on Fatigue Phenomena in Metals was the somewhat formidable title of the committee. The chairman of that committee was Prof. H. F. Moore of the department of Theoretical and Applied Mechanics, and during the war and afterward some small pieces of research work were carried out under the auspices of the committee, mainly in the materials testing laboratory of the college of engineering of the University of Illinois by the chairman of the committee, and by W. J. Putnam, and A. G. Gehrig. The National Research Council recommended that the bulk of the income of the Engineering Foundation be given to the support of an extensive investigation of the resistance of metals to fatigue under repeated loading, and that Professor Moore be asked to take charge of the investigation.

This suggestion was followed and the formal arrangements have just been completed for the active prosecution of this work, with headquarters and a laboratory at the University of Illinois. The financial support for the investigation will amount to $30,000, and the investigation is expected to extend over a period of two years. Material for study and apparatus is already arriving, and a room is being fitted up for the installation of the score or more of special testing machines which will be required for the investigation.

The investigation is under the joint auspices of the Engineering Foundation, the University of Illinois Engineering Experiment Station, and the National Research Council, the last-named body being represented by an advisory committee of nine members, of which Professor Moore is chairman. In addition to the funds supplied by the Engineering Foundation, the University furnished Professor Moore's services, light, heat, power, a laboratory room, and the use of the standard testing equipment of the materials testing laboratory.

The investigation is one of the most important ever undertaken by the Engineering Experiment Station. The fund available is the largest ever devoted to a single engineering investigation at Illinois, and one of the largest ever devoted to any investigation at the University. The sudden failure of crank shafts, axles, and springs is all too common in automobiles, railway equipment, and machinery in general; and the ability of the new high-strength steels to resist repeated loading needs much more study. The problem is one of national interest and the September 27 issue of the *Literary Digest* gave a summary under the title "Tired Metals," of a recent lecture by Professor Moore on the subject.

The State University of Iowa.—I think perhaps it is worthy of note that the College of Applied Science, which is the engineering college of the State University of Iowa, has taken what it thinks to be a step in advance toward the devotion of the four-year college course in engineering to the development of the fundamentals of the profession of engineering as distinguished from the development of specialists in one or another branch of engineering.

The college offers five distinct courses, namely courses in Civil Engineering, Mechanical Engineering, Electrical Engineering, Chemical Engineering and Chemistry. These are all four-year courses except the course in Chemical Engineering, which is a five-year course.

By action of the faculty last year, which action was put into effect this year for the first time, the first-year work in the four engineering courses is alike and the civil, electrical, and mechanical courses differentiate only in the senior year and then only to the extent of twenty of the thirty-four semester hours constituting the year's work.

All students in these courses receive the same instruction in the ordinary fundamentals of mathematics, chemistry, drawing, shop work, surveying, physics, descriptive geometry, mineralogy and geology, mechanics, materials of engineering, hydraulics, machine design, stresses in static structures, steam engine, the generation, transmission and delivery of electric power.

They also receive the same instruction in economics, accounting, business law, English and metallurgy.

In the senior year special work in surveying and railroad surveying, structural engineering, road engineering and sanitary engineering is given to civil engineering students. Special work in the theory of electricity, electro-chemistry, telephone and telegraph, illumination, dynamo design and power plant engineering is given to electrical engineering students. Special instruction in shop work, heat engines, engine design, heating and ventilating and power plant design is given to mechanical engineering students.

Pennsylvania State College.—The new machine and forge shop building was informally dedicated on the evening of November 25, just a year after the date when the old industrial shops were destroyed. Since that time a new building devoted to wood-working has been completed and equipped with the most modern machinery and a second building for metal-working.

A third building will be in use at the beginning of the second semester and will contain the testing materials laboratory, the highway and masonry laboratories, the offices and recitation rooms of the Department of Mechanics and Materials of Construction. Each of the buildings above mentioned is three stories in height and two of them have basement floors.

The new Mechanical Engineering Laboratory has been started and its completion is promised in time to receive the new equipment before College opens next September. The new building will be 60 feet by 165 feet with a basement for condensing apparatus and a gallery floor for lighter equipment.

PITTSBURG SECTION OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

First Regular Meeting.—Wednesday evening, December 3, 1919, 8 P.M., at the University Club. (Take Fifth Avenue car and get off at Bigelow Boulevard. The Club is on Bigelow Boulevard between the Syria Mosque and the Pittsburgh Athletic Association.)

Engineers, employers of engineers, teachers of engineers, and all others interested in engineering education are invited.

General topic for the 1919–1920 meetings: "How Can the Education of Engineers be Improved?"

Special topic for the first meeting: "What Are the Chief Defects in the Product of Engineering Schools?"

Speakers: Mr. B. F. Groat, Aluminum Company of America, 15 minutes; Mr. D. F. Crawford, Locomotive Stoker Company, 15 minutes; Mr. Carl S. Coler, Westinghouse E. & M. Company, 15 minutes.

General discussion: Limited to three minutes to each speaker.

MATHEMATICAL COMMITTEE.

Special discussion: "What Defects are Properly Chargeable to the Engineering Schools?" F. L. Bishop, dean, School of Engineering, University of Pittsburgh, 10 minutes. "What Defects Can the School Hope to Remedy?" W. E. Mott, dean, School of Applied Science, Carnegie Institute of Technology, 10 minutes.

P. M. Dysart, *Chairman.*
L. H. Harris, *Secretary.*

University of Pittsburgh.

BOOK REVIEW.

Geodesy.—By George L. Hosmer. John Wiley and Sons, Inc. 1st Edition, 377 pages, 6 × 9, 115 cuts, cloth, $3.50 net.

Contains considerable more information than could be covered in class in the time usually available for such work. Has a large number of excellent cuts of the various instruments and apparatus used in geodetic work. The chapter on astronomical observations is not in sufficient detail for teaching purposes. It assumes a general knowledge of astronomy and the ordinary methods of determining time, latitude, and azimuth. It includes a chapter on the determination of the earth's figure by means of gravity measurements. Devotes forty-six pages to an introduction to the method of least squares and the adjustment of observations by that method.

L. W. McI.

MATHEMATICAL COMMITTEE SOON TO ISSUE PRELIMINARY REPORT.*

A preliminary report on "The Reorganization of Introductory Courses in Mathematics in Secondary Schools" will shortly be issued by the National Committee on Mathematical Requirements.

---

* *School Life,* Vol. III, No. 10.

MATHEMATICAL COMMITTEE.

This report has been prepared by a representative subcommittee. It has not as yet been considered by the national committee, but its publication as a basis for discussion by teachers' organizations, committees, and local groups has been authorized.

A report on "The valid aims and purposes of the teaching of mathematics in the light of recent criticisms" will, it is hoped, be ready for distribution by January. In it an attempt will be made to state precisely and succinctly the mathematical training that every citizen should secure. The findings of this report can then be made a basis for the determination of precisely what and how much mathematics should be required of all students.

An extended investigation of "Experimental schools and courses" is being undertaken for the committee by Mr. Raleigh Schorling of the Lincoln School. Detailed plans for this investigation were approved by the national committee at its last meeting in New York City on November 1.

Mr. J. A. Foberg is preparing a report on "Mathematics in junior high schools."

Prof. A. R. Crathorne has recently submitted a report giving the results of his investigation of " Change of mind between high school and college as to life work." Professor Crathorne is at work on an extended investigation entitled "A critical study of the correlation method as applied to grades."

A statement of general principles to govern the proposed revision of college entrance requirements has been tentatively approved by the committee. This statement has been sent out to some fifty representative colleges and universities for their criticism and comment.

The committee has sent letters to all teachers' organizations having mathematical interests, of which it has been able to learn, asking their coöperation and offering the assistance of the committee.

BULLETIN

OF THE

Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee:
Arthur M. Greene, Jr., John F. Hayford, F. L. Bishop, *Editor*.
Address all communications to the Editor, University of Pittsburgh, Pittsburgh, Pa.

VOL. X LANCASTER, PA., FEBRUARY, 1920 No. 6

TABLE OF CONTENTS.

On Motivation. W. K. Hatt 186
Coöperation of the College, U. S. Bureau of Mines, and Industrial Corporations in Research Investigations. E. A. Holbrook 199
What are the Chief Defects in the Product of Engineering Schools? B. F. Groat 207
Editorial 212
Time of Meeting of the S. P. E. E. 213
Coöperation Between Engineering Colleges and Industries. Ernst J. Berg 214
Culture 215
Necrology 215
College Notes 222

ON MOTIVATION.

BY W. K. HATT,

Professor of Civil Engineering, Purdue University.

The writer will endeavor to summarize the recent views upon the subject of motivation, and the methods of teaching that are expected to motivate the student.

Someone at the Baltimore meeting asked the meaning of "motivation." The reply was that motivation is what the student in the class in gunnery had the day before the armistice, and what he did not have the day after. It is the purpose that energizes a senior when given a real job, as in a thesis, different from the unreal and partial exercises or patterns of his routine work. It is what turns a careless youth into a serious, efficient, forward-looking man when he has a wife and family to support.

It is not, however, the purpose of this article to discuss these generalities, but rather the changes in curricula and in methods of teaching, proposed to secure motivation.

The Motivated Teacher.—The teacher himself should be motivated. He should not settle down to a routine job in which he is not interested.

What keeps teachers at their work is less mainly their interest in the routine of teaching and the tools of instruction than the liking for this art. Paul Bourget, in "L'Etape," a novel marked by unusual elevation and nobility of thought, has described a teacher of social science, a man of enthusiasm for things of the mind, and he comments on the function of the educator as follows:

> "un vrai professeur tel que celui-là, un de ces accoucheurs d'esprits, possédés par la passion du talent jeune. Les éducateurs de grande race éprouvent, á discerner dans un écolier de dix-sept ans les premiers linéaments de la supériorité future, des émotions d'inventeurs et d'artistes.

Préciser, hâter l'achiévement de cette ébauche, conspirer á l'éclosion de cette noble fleur humaine, s'associer á ce miracle: la formation d'une belle intelligence, telles sont les délices de ces maitres, qui demeurent le plus souvent anonymes.''

The writer ventures to translate freely this passage:

''. . . a real professor such as this, one of the mid-wives of intelligence, filled with a passion for budding talent. Teachers of high type seek in a scholar of seventeen years the first features of a future superiority, the emotions of inventors and artists. To make these precise, to hasten the completion of this rough sketch, to plan for the opening of this noble human flower, to associate themselves with this miracle, namely, the forming of a beautiful intelligence—these are the delights of those masters who remain most often anonymous.''

This quality of inspiration which kindles the divine spark into flame, is the possession of a great teacher. He may be late for his classes, a poor bookkeeper, or drill master, but if he has this quality and a human sympathy, his students will rise and call him blessed.

But the teacher may also be motivated by research either in the field of the physical sciences, or in his own field of teaching. Freedom from prejudice, and willingness to follow the truth, qualities associated with research, are of high educational value and should be part of the equipment of the teacher. A life of unmixed schoolteaching is quite generally deadening.

Motivation of the Student.—The motivation of the student is proposed either by (1) the so-called ''direct'' method of teaching, which proceeds from principles to application, or by (2) the so-called ''situation'' method, which uncovers principles by an analysis of several real situations.

The first method uses deductive logic, as in mathematics. The student follows patterns of thought, abstract in nature, that have served well for so many generations. Under this method, the desire to accomplish a difficult task, and the delight in the exercise of mental powers are certainly sufficient motives for many students. A clear statement of the end to be sought, and an explanation of the bearing of the task upon some future purpose of the student, will serve for others.

Writing on *"The Natural Method of Teaching,"* in the BULLETIN of this society for November, 1916, Mr. Sanford Moss, of the General Electric Company, insists that there must always be a clear statement of the purpose in order to sustain the interest of the student. Mr. Moss cites the books of Euclid, where a complete statement of the result to be reached was given at the beginning of the demonstration, while at the end comes the familiar Q.E.D.

Mr. Moss has given a clear statement of the second or "situation" method, and he goes as far as more recent writers in re-arranging the sequences of studies, in teaching through situations, in approaching the abstract from the concrete. His article seems to have attracted but little attention, but it defines the question at issue.

The center of the ideas, back of the second method, associated with the name of Dr. Mann, is simply this: that abstract principles should be reached and organized through an analysis of real situations, that is to say, through situations to which are attached all of those circumstances, which are considered by an engineer or other person who must reach a decision in the face of these circumstances. A set of principles is uncovered by approaches from several situations. In other words, we go from multiplicity to unity, a much more difficult method, demanding a very skillful teacher in order to insure coördinations on the backward path.

In the bulletin of the society cited above, Dr. Mann summarizes his investigations of engineering schools under the auspices of the Carnegie Foundation. One of his first conclusions was that instruction should not only develop technique and mastery of principles, but also integrity, initiative, resourcefulness, and common sense. He is also struck with the fact that so many young men with pronounced engineering talent are unable to make good in the engineering schools.

He questions the method of presenting the subject matter in schools as determined by the teacher's conception of logical rigor and theoretical unity, and inquires if some study should not be given to the problem of more efficient methods through which students could accomplish their work, just as industrial managers study the methods by which the individual worker can best perform his task.

The success of Professor More, of the University of Washington, in teaching mechanics led Dr. Mann to ask: Why not give real problems first instead of abstractions? It appeared to him that the task required of the student was not too hard, but the preparation was so abstract in character that there was little connection in the student's mind between the preparation and the task. Dr. Mann thought if the job that a man had to do was understood by him, the preparation would have more meaning and would be undertaken in a better spirit. He thought the work should be more concrete.

Mr. Moss, in his article cited above, would cast off the chain by which most colleges bind themselves; as for instance, that a pupil cannot take calculus until he has analytical geometry; mechanics until he has had calculus; and machine design until he has had mechanics. Mr. Moss thinks that the necessity for such succession is purely imaginary. Instead of working out formulas for stresses in beams before the pupil knows what a beam is and the use of the formulas, he would work in machine design with arbitrary formulas and later on, go through the process of derivation. So, therefore he proposes the use of the principles first and the development afterwards.

The subject of motivation became increasingly important during the war. The theory of the American Army was that the soldier should have an intelligent idea of what he is fighting for.

The vocational detachments at the training schools were taught by the job sheet method. A series of jobs or operations of graded difficulty were arranged—as in auto-mechanics, surveying, concrete construction, blacksmithing, etc. For each job a "job sheet" was prepared. The thing to be done was definitely stated and limited. Then followed a series of development questions to accompany the performance of the job. These were not like examination questions to be answered after the event. Rather, they were an analysis of the job, and accompanied its performance. Each one called for a decision by the student on the basis of the developing circumstances of the job, or by reference to information in a text. The instructor was to do as little lecturing as possible, and not to answer the questions for the student. The soldiers were not to advance through the shop courses in companies, but rather to infiltrate the subject. Each one went as far as he could and was so certified. It will be seen below that this method of teaching, arranged for a rather simple variety of instruction, was followed in its essence at the Engineering School for Army Officers at Camp Humphreys.

A course of lectures in War Aims was arranged to motivate the soldier. Here the teaching of history was from modern times backward—"starting a student where he is," a phrase attributed to Benjamin Franklin.

The work of Professors More and Duckering in teaching mechanics at the University of Washington by the situation method is well known and has been thoroughly described in the BULLETINS of this society. In the course of events these teachers were detailed to the Engineer School at Camp Humphreys, where the young officers graduated from West Point after two years of attendance, were to be taught the engineering courses. There came about an opportunity to try out the situation method on a large scale, not only in mechanics, but in the engineering courses.

In June, 1919, the Engineer School was surveyed by a group of educators. The operations and courses were reported upon in a pamphlet published by the Committee on Education and Special Training of the War Department, entitled "The Engineer School at Camp Humphreys." This report should be read by all those interested. The reporters analyzed the methods of More and Duckering in teaching mechanics, and the process, as far as the student is concerned, appears in the table below.

Chart Indicating Relationship between Type of Instruction and Preliminary Purpose in Course in Mechanics of Engineering School, Camp A. A. Humphreys, Virginia.

The Student.	Subject Matter.	
Interest aroused and maintained by contact with Engineering Situations.	Motivation. Project or Problem.	
Independent thought and judgment stimulated by analysis of raw problems.	The Setting. A concrete engineering situation.	As a whole. In part.
Effective Habits of work and study, and Practical uses of working tools established.	The Analysis.	Process. Working Tools.
Acquaintance with Fundamental Principles and Knowledge of their relations to solution of Problems.	Principles.	Basic. Derived.
Coördination and Fixation of ideas.	Rules, Formulas, References, Data, Text.	
Outlook. Expectancy concerning future studies.	Deferred Analysis. Advanced Theory and Research.	

The student is taken to a bridge, for instance, and the necessity, use and practice of mechanical analysis based upon this real situation.

The distinctive feature of the engineering courses such as foundations, roads and bridges is, that in each course there is a major problem with related minor problems constituting a framework upon which the student hangs the subject matter of the text. The major problem is a complete structure that the student is to design, or an engineering project that must be reported upon. A complete description of the situation is given and the controlling conditions are to be determined. In his report the student is required to make decisions, and is thrown back to the text for information, theories, or principles, that control the decision. For this purpose the major problem is further analyzed into a number of minor problems that are related to the whole project, and serve to keep the student's interest alive, and to guide him in the necessary degree in the sequence of the necessary decisions. The development questions are used as in the job sheets for the vocational work. Sketches rather than detailed drawings are made by the student. Each subject is studied intensively for about 6 weeks. Mechanics and mathematics precede these courses.

At Purdue University the writer had modified his methods in certain senior courses in concrete construction along the lines of the Camp Humphrey report with very satisfactory results. The text-book is Hool and Johnson's "Concrete Engineers Handbook." The students are confronted with a concrete retaining wall that has not hardened, and of which the history of the materials and the manufacture are known. A letter from an attorney asks for a report as to the probable cause of failure, and states that the report must be substantiated in court. The materials are tested; the entire field of materials in the text is searched for possible causes, and with a purpose in view; records must be clear and the report plain to a layman; personal responsibility is felt.

Such courses must not be improvised; indeed they require the most careful planning, and close contact with the student.

Another proposal leading to motivation is a series of so-called vestibule courses for freshmen.* The freshmen are to be divided into small groups. Each group accomplishes several engineering projects throughout the year under one instructor. For instance the student is furnished a topographical map of a dam, reservoir site and power house. He reads this map, learns the purpose of the dam, and its appurtenances. He calculates the watershed, the volume of the reservoir, its center of gravity, the power factors, and so on to the delivery of the power. In this way the operations of simple mechanics, mathematics and the conceptions of physics are attached to an interesting situation. They have more meaning to the student and are more firmly grasped. The

* The writer understands that these have been put in operation at Tufts College.

too great abstraction of the freshmen and sophomore year are avoided.

These courses also serve to orient a freshmen who has only a vague idea of the work of an engineer.

There are not wanting those who would break down the barriers between the separate departments of mathematics, physics and mechanics and teach them concurrently as parts of a whole problem.

To determine what method to use and when to use it, we need a direct trial of the relative efficiency of the proposed methods, and the standard methods, made upon different groups of students, whose mental status is known in advance from intelligence tests. One group should consist of men of quick apprehension, such as are now signalized by such tests as that for "engineering aptitude," and another group should consist of men with a slower, but more logical and tenacious mentality. With the raw material classified, the appropriate tools may be selected to fit the material. And the art of the "born" teacher may become the science of his less fortunate colleague. Teaching might become a profession,, and not a stepping stone to business, administration, or marriage.

Discussion.—It appears then that the aims of education and the methods of instruction that have apparently satisfied so may generations are under scrutiny and criticism. To conservative teachers, whose ideas and methods are derived from tradition, some of the recent proposals seem disorganizing. However, they are voiced by an increasing number of responsible educators, and must be seriously examined.

The teacher should take the middle of the road between the over enthusiastic individual, on the one hand, and, on the other, the blind reactionary who allows an organization to become rigid, the life gone out of it, seeking a home in a new body.

Are we to develop a product to which measurements can be applied, a mechanism that functions definitely? Most college teachers will not admit this test; they claim a certain elevation of mental level, and in proof point to the future progress of their students. There is an element of self-persuasion here, and the results may not be due to the teacher.

Many teachers will deny that a student needs the kind of interest in his studies that comes from a conscious, patent plan of motivation, secured through the concrete, working back from real situations. They believe that this will only lessen the final power of quick comprehension and abstraction of complicated situations in the case of minds of high caliber. Pupils who must be approached by methods variously referred to as "objective," "situation," "job," "by doing," "starting a man where he is," should, in their opinion, be used in vocational schools and not in the university. This is of course an undemocratic view.

It appears to the writer that engineering work needs many varieties of intelligence. In our technical schools we tend to stress too highly the mentality of the designer, and we fail to reach that student who reacts to problems of construction, of management of men—one indeed who so often only reacts (to his own disadvantage) to the realities of class and student activities, things which President Wilson calls the side-shows.

In the endeavor to produce the efficiency that the business world demands of our graduates, our students should not be deprived of the training of the imagination which underlies the ability to plan, to organize, to design. By imagination I understand what Baudelaire describes in his preface to his translation of Poe's stories ("Nouvelles Histoires Extraordinaries"):

> "L'imagination est une faculté quasi divine qui percoit tout d'abord, en dehors des méthodes philosophiques, des rapports intimes et secrets des choses, les corréspondancés et les analogies . . . un savant sans imagination apparait plus que comme un faux savant, ou tout moins comme un savant incomplet."

> "The imagination is a faculty quasi-divine, which perceives at first, outside philosophic methods, the intimate and secret relations of things,

correspondences and analogies . . . a *savant* without imagination appears only a false *savant*, or at least as an incomplete *savant*.''

Nor in the endeavor to start a student ''where he is,'' should he miss the opportunity to re-think the thoughts of the master minds of the past, and to cherish the ideal. If we start our courses in history and philosophy in the confused issues of the present time, would the student be likely to get back as far as Plato's ''Republic''?

Finally, will the ''discipline'' resulting from the drill of the freshmen year, be sacrificed to the interest secured by the ''situation'' method; and will it be humanly possible to secure the expert teachers, the small sections, demanded by the latter?

Conclusion.—The situation method is a valuable tool for teachers. Its field is yet to be determined. It will retain in the university for further education a variety of engineering intelligence.

Recent Articles Connected with Motivation.

1. ''The Engineer School at Camp Humphrey,'' published by War Department.
2. November, 1916—''Study of Engineering Education,'' by C. R. Mann. ''The Natural Methods of Learning,'' by Sanford E. Moss.
   May, 1917—''Mechanics of Engineering at University of Washington,'' by W. E. Duckering.
   December, 1918—''Liberal Element in Engineering Education,'' by G. F. Swain.
   February 1919—''Effect of the War on Engineering Education,'' by C. R. Mann. ''Training Required for Engineers,'' by General Black.
   May, 1919—''Colleges and the War,'' by Professor F. P. McKibben.
   September, 1919—''Reflections of a S. P. E. E. President,'' by Director Hayford.
   October, 1919—''Problem Method at Engineer School,

Camp Humphreys," by C. C. More and W. L. Duckering.

3. "Comments on Course in Engineering Mechanics at Engineer School," by Lieutenant W. E. Duckering. Published by Engineer School.
4. *Proc. Am. Soc. of C.E.*, Vol. XLX., No. 6, Report of Delegation of American Engineers.

QUOTATIONS.

By Professor Frank P. McKibben ("The Colleges and the War," BULLETIN, May, 1919):

> "He expects something new, something better, than he had at high school. But he finds he has almost exactly the same subjects to study—mathematics, English or German, chemistry or physics. His enthusiasm drops x per cent. at the first recitation and another x per cent. at those immediately following as he rushes from building to building in the hope of finding something to satisfy his longing to become an engineer."

By General William Black (Discussion, BULLETIN, February, 1919, p. 226):

> "Why teach arithmetic, algebra, trigonometry and all the rest separately, and not use all progressively as the more intricate computations are reached, using for each class of problems the mathematical process best suited for it?"

From the Report of Delegation of American Engineers, *Proceedings, Am. Soc. C. E.*, August, 1919:

> "The opinion was also expressed by the French engineers that the teaching of general studies and sciences in the technical schools should be practical and directed to the needs of the engineer. The instruction in mathematics should not be abstract and theoretic, but practical and concrete. The same is true with regard to instruction in languages and other studies. This tendency is the same that is observable in many of the schools of the United States, and they were heartily approved by the American representatives."

Mr. John F. Hayford ("Reflections of a S. P. E. E. Presiment," BULLETIN, September, 1919):

"I believe that an engineer needs intelligence and must use it,—but not simply a particular kind of mechanical mathematical intelligence.

"As motivation is extremely important to our success as educators should we develop a new motivation in the place of the lost military motivation?

"Which should receive the main emphasis, specialization or general education? The answer is, I believe, both, alternately.

"Similarly, there are those who advocate strongly the presentation of theory first,—practice, concrete examples, laboratory work later. And vice versa, there are those who advocate always taking the reverse order, the observation first and the theory later. Are they not both partly wrong and partly right? Does not the man proceed normally and most effectively by alternating the two in rather short periods?"

"The engineer's greatest service is based largely on his ability to see the things that are not obvious, to see the possible advances that are but obscurely indicated, to see in the blueprint and the description that which is a possible future fact worth while."

"The greatest defect in our educational system at present is the lack of vocational training."

Dr. C. R. Mann ("Effect of War on Engineering Education," BULLETIN, December, 1918):

"The War Department's experience with training soldiers shows that first essential of effective teaching is a clear definition of the result desired.

"The conclusion of psychologists agrees with the experience of the war instruction that knowledge is always specific and is developed best by mastery of specific tasks.

Dr. C. R. Mann (Discussion, BULLETIN, February, 1919, p. 214):

"That is, those who thought that the solution of education consisted in putting the real and practical before the theoretical, and others believed the theoretical should go first. I have now reached the conclusion that it does not make any particular difference, provided the boys want to do it. The fundamental point is to get the boys to want to do it. Sometimes it is advantageous to go from the theoretical to the practical application and sometimes from the practical application to the theory, all depending upon the skill of the teacher; in the individual it does not produce the effect if the boys really want to do it."

Professor G. F. Swain ("Liberal Element in Engineering Education," BULLETIN, December, 1918):

ON MOTIVATION.

"The subject of this paper is mainly motivation, or by doing work with a distinct motive, gained by being able to see what is being done, the need and use and application of it, which is only possible, if my view is correct, if it can be related to experience.

"No effective results will follow unless the student is interested and sees the value, use, and application of what he studies.

"The difficulty is that in the study of these subjects the student may not be able to relate them to his experience, that is, his work is not motivated, and so he achieves small results.

"The main object of the instruction should be to teach the students to think for themselves. The instruction should be concrete and practical, rather than abstract and theoretical, and should be accompanied by practice in the application of the subjects studied."

Rev. Edward Mewburn Walker, Queens College, Oxford (Address, BULLETIN, January, 1919):

"For what we claim there is this, that the student shall be allowed to study that subject which appeals to him; not up to certain points but up to any points he pleases, and he shall study it in such a way as to clear his mind so to give him power of thought, of criticism, of inference; in a word, to give him a better mind, a better instrument than he started with.

"Now, the great gifts the study of the humanities can impart, besides this general gift of thinking, are the gifts of imagination and sympathy.

"For that quality of leadership is needed quite clearly these two gifts of imagination and sympathy."

Dr. John Joly, University of Glasgow (Address, BULLETIN, January, 1919):

"The difference between the student who can rely upon his mathematics and who knows how to state his problem in proper form so as to apply mathematics to it, and the student helplessly going about to get somebody else's brain to help him out of his difficulties is enormous. To my mind, that constitutes the difference between the good engineer and, speaking generally, the second rate engineer; I do not say it is always the case, but in general that is the case.

Shakespeare ('Taming of the Shew," Act I., Sc. I., Line 40):

"In brief, sir, study what you most affect."

Rabelais ("Gargantua," lvii):

"Fais ce que voudras." "Do what you wish."

CLOSER COÖPERATION OF THE COLLEGES, U. S. BUREAU OF MINES, AND INDUSTRIAL CORPORATIONS IN RESEARCH INVESTIGATIONS.*

BY E. A. HOLBROOK,

Superintendent, Pittsburgh Station, Bureau of Mines.

A part of the Organic Act of the Bureau of Mines charges it with the furtherance of safety in the mining industry; making investigations for the prevention of waste, promoting economic development and conservation of the mineral resources, investigating utilization of mineral fuels; and the dissemination of the information obtained. How better can this be carried out than by close coöperation by the bureau with the colleges and the industrial corporations? The college is the proper place for the training of men to carry on the research work, and the Bureau of Mines an official agency for conducting general commercial research, especially in those fundamental problems the solution and application of which is to benefit the whole mining industry; or those problems the solution of which is of so expensive a nature or of such general application that a single corporation cannot, as a financial business concern, afford the time and money necessary. Finally, the research itself must concern and be of benefit to the mining companies and industrial corporations or to the men employed by them. It is through the business world that practical modification and application of ideas and processes which have been developed by the other agencies must be put into application.

A government investigational bureau may adopt one of two policies in its development. It may pick out a central location, concentrate its staff, buildings, equipment and energies there and become the recognized center for its special line of work, and to which colleges or corporations may come for coöperation, assistance and advice; or, on the other hand, it may establish central administrative headquarters only and distribute its personnel and equipment in separate stations throughout the country. This policy leads to an especially intimate contact with local institutions and problems and keeps it in close touch with the actual industry. The Bureau of Mines is carrying out the second policy.

---

* Presented at National Conference of Schools of Mines of the American Mining Congress, St. Louis, Mo., November 17-22, 1919. Published by permission of Director of Bureau of Mines.

The first complete coöperative field experiment station was the Salt Lake station, where in 1914 a coöperative agreement was entered into between the University of Utah and the Bureau of Mines by which the bureau should establish a field experiment station at the university and have the use of certain university offices and laboratories and be given light, heat and power, and the assistance and coöperation of the teaching staff of the university. On the other hand the bureau would maintain a staff of engineers and metallurgists there whose work should be the solution of mining and metallurgical problems which might prevent waste in the industries, increase efficiency and conserve human life. The university further agreed to establish fellowships, the holders of which should be paid by the university and who should work under the direction of the bureau engineers and on commercial problems which were receiving the attention of the bureau staff.

While preference has been given local problems, yet problems arising in distant districts, the solution of which might aid in the industry and on which the experimental work would be valuable in the training of the student body and fellows, have received equal attention. Care has been used not to conflict with the professional activities of private consulting engineers and the mere treatment of an ore or mineral substance to determine its adaptability to a known process has been considered secondary to the development of new processes or the adaptation of processes to conditions hitherto not thought possible. Experiment stations of a similar nature later were established at the University of Arizona, Tucson; University of Washington, Seattle; University of Minnesota, Minneapolis; Colorado School of Mines, Golden; and the Ohio State University at Columbus. Field stations without college affiiations also have been established at Fairbanks, Alaska, and Bartlesville, Okl., where needs arose but whose location did not admit of coöperation with colleges. At the University of Illinois, Urbana, and the University of California, Berkeley, coöperative agreements have been entered into and limited stations established. They do not, however, receive the full station appropriation from the bureau and their staff is confined to such engineers and metallurgists as has been possible to allot from general bureau funds from year to year. The limited coöperation at Urbana, made first in 1911, is jointly with the Engineering Experiment Station of the University of Illinois and the State Geological Survey and was the first coöperation of the bureau with state and college agencies for conducting investigations.

The main field station of the bureau at Pittsburgh, Pa., has recently entered into a new kind of coöperative agreement with the Carnegie Institute of Technology. The Pittsburgh station, especially in coal mining laboratories, gas, fuel and petroleum testing, has built up large working sections of its own for the solution of problems in these various lines which may arise anywhere in the country. At the present time it is coöperating with a number of industrial corporations and commercial agencies in the solution of general problems, the results of which will be accessible to the industry. For example, the fuel-testing section has agreements with several industrial concerns, with the Shipping Board, and with the War Department by which tests are being carried out under the direction of the bureau, the cost of which is being paid either wholly or in part by the other coöperating agency. The American Society of Heating & Ventilating Engineers is conducting at the Pittsburgh station, under coöperative agreement, a study of ventilation and heat transmission problems. The petroleum section is likewise coöperating with that industry and similar work is being carried on in the chemical and metallurgical sections. The bureau, moreover, is constantly testing commercial explosives and apparatus designed for use in the mines with a view to giving them bureau approval for safety. This work includes testing of mine lights, electrical and gasoline underground locomotives and electrical coal-cutting machinery, permissible explosives, oxygen breathing apparatus, and gas masks for industrial purposes. In this way the bureau is in direct and constant contact with the industries and their needs.

It is desired that educational institutions and the industries have access to the station and be able to take every advantage of results being obtained there. For this reason the bureau has been glad to enter into a coöperative agreement with the Carnegie Institute of Technology by which their undergraduate students in mining may visit and inspect the work being done at the Pittsburgh station, and their graduate students and fellows may be assigned work and take part in the tests and researches being conducted by the bureau. Since the problems engaged in are commercial problems, mostly put up by the industry and of direct benefit to them, such an agreement offers an educational institution a chance to bring the men they are training into intimate contact with the developments and future needs of the industry. It is hoped that other institutions may make similar coöperative agreements with the Pittsburgh station.

The bureau further stands ready as part of its program in the dissemination of information, to set aside one or more weeks in each year in which students of mining or in other engineering and scientific departments of colleges may come to the Pittsburgh station and enter into and have explained to them by special demonstrations the researches under way there.

Why are the colleges, the Bureau of Mines and the mining industries each necessary to the other for the proper development of mining and allied research?

The college wants to furnish graduates trained to be of value to the industry; the industry is eager for ideas, processes and men that are of commercial value. The bureau must be of value to them both.

Both the college and the bureau have one common object in view, the furtherance and upholding and application of science to the mining industry.

In the past a tremendous amount of research work has been conducted by the colleges alone and a host of problems solved in this yay. With the development of the research idea in industrial corporations many problems are arising, the scope of which is so broad and the expense and time necessary so great that the college needs outside help.

The college or university is primarily an institution for the young men's development and education and secondarily, one for research. It therefore recognizes that having a staff on the campus, who can devote their whole time to research means a greater gain to the research work of the institution than would be indicated by the mere amount of money allotted by the bureau there. It is often stated that the modern engineering school is in close touch with the industries and is no longer isolated on purely abstract and theoretical considerations; however, the very nature of the training which should be developed in the school requires that the institution become not too practical and its staff not too taken up with commercial work lest the college lost its ideals and purposes which make it a place of training superior to that of the shop or field. On the other hand teaching is a profession by itself and even in engineering a man who must devote the entire day to teaching has only a limited period each year in which he can hope to come in contact with other men in his profession and with the corporations themselves. Somehow, the bureau places students and faculty in a position in which they feel more closely in contact with the industry. The bureau men, traveling about in the field for part time and working at the college for part time are enabled to bring the professional point of view close to the college.

Large parts of many college laboratories under ordinary conditions must be idle for many months in the year. This is not a criticism of the laboratory but a necessary overhead expense which the colleges recognize and which they would gladly overcome were more money or a greater number of classes available. A piece of apparatus perfectly adapted for research work may serve a single class for a single day and then lie idle for half a year or a whole year, until new classes take the same work, unless opportunity is developed for research work. It is therefore of tremendous interest and help to students who often see only their instructors engaged in laboratory and test work to be able to see the Bureau of Mines men working as professional engineers on the same class of problems with which they are expected to familiarize themselves.

From the bureau point of view it has been logical to seek location at or near a college or educational institution where college office space and equipment are available, where the faculty are in touch with local needs and situations and where the surroundings are congenial for research and mutual help.

Another point which must not be overlooked is the ideal chance offered in this way for the bureau to get its ideas and results of its research across to the engineering public. Although it is a government institution it is without police or mandatory powers and its effectiveness depends on getting its work across, on the one hand, to the practicing industry and, on the other, to the men who will control and direct industry within the next few years. In engineering, as in medicine, it is the undergraduate who receives the advanced ideas and processes and, although later practical experience may make him more conservative as to introduction and application of new ideas, yet his very association in college with advanced principles and processes gives him that flexibility of mind necessary to apply new ideas, which never leaves him.

His association with the station as an undergraduate or graduate student gives him the "bureau point of view." This coöperation between the bureau and the college for the carrying out of research work is an ideal one; working together they can present to the industry with double strength things which they believe are for its betterment.

Every corporation has its own research problems. A research laboratory of a corporation is engaged primarily in the problems whose solution is of direct benefit to the corporation and the only point of view is the application of the problem to the commercial success of the corporation. While the large corporations a few years ago felt able to handle their own research problems, the writer ventures that today there is not one of the corporation research departments but that will admit there are basic and far reaching problems which should be solved for the benefit of the whole industry and whose solution would be of direct benefit to them in their work. They further admit that they cannot possibly consider taking the corporation money and time to work on these problems, the solutions of which might be of as much or more benefit to their competitors as to themselves. Further, the results of corporation research generally are not available to the public.

The small corporation in every case must look to outside help on its problems. True industrial research is a slow and costly problem not at all adapted to a small commercialized department which must show decided progress each day.

The industries often fear that solution of their problems by the colleges may involve such a departure from the dollars and cents consideration that they will not benefit by them and that on account of the demands of the college teachers for regular work the time taken may be too great a factor. That they have been willing to coöperate with the Bureau of Mines or with the bureau and college jointly has been proven in many cases during the past few years.

Finally, the bureau, on its part, needs both the other agencies. It must have the college to foster and keep alive for it the ideals of research and to furnish the very material help in men, materials, or ideas, and because it opens to the bureau the most fertile field for the distribution of results and ideas from research. On the other hand the bureau must be of direct service to and at the call of the industry, and the industry must be satisfied that the bureau's help is worth receiving and its ideas practical and worth adopting else it cannot continue to exist. Therefore, the bureau stands ready at all times to coöperate with the industry and with the college in the solution of problems of benefit to the industry.

WHAT ARE THE CHIEF DEFECTS IN THE PRODUCT OF ENGINEERING SCHOOLS?*

BY B. F. GROAT,

Hydraulic Engineer, Aluminum Company of America, Pittsburgh, Pa.

This question must be considered broadly by the teacher, especially when determining his general educational policies and when establishing his courses of study.

The question can be answered in its broadest sense only when we have determined the future conditions under which the engineering graduate must work and the functions which the graduate will have to perform under these conditions. At the same time, we work under the disadvantages of having to arrive at conclusions based upon future conditions in only the light of past experience.

We have passed through a period of great revolutions, the principal one of which is the changed conditions of world society due to the world war. International relations have been disrupted without having been completely reëstablished on a new basis. National economics must be remodeled; the rights and duties of men will have to be redetermined, and reapportioned.

Perhaps the most potent moral force is that which in the past has been called the law of public policy. This law will become more and more potent as time rolls on. We already see unmistakable evidences of the tendency of governments to investigate, interfere with and direct business of a private nature. It is not improbable that we shall see efforts made to determine what is and what is not legitimate business; what is and what is not proper individual occupation; what is and what is not permissible economic activity.

---

* Read at the first regular meeting of the Pittsburgh Section of the Society for the Promotion of Engineering Education, Wednesday evening, December 3, 1919.

It is already a fact that private incomes are investigated and taxed and there are already laws in many codes of various nations prohibiting strikes and denominating them conspiracies where they interfere with industries of vital economic importance.

The laws of civilization naturally base themselves on the principle that they are just if best for society as a whole. This is merely the broadest conception of the law of public policy. Such policy and laws establish themselves by virtue of moral forces which are above man, though they express themselves through the agency of man. Why is it that we see congressmen, senators, presidents, kings, queens, voting for prohibition? Do they want it? Did they vote for it from the start? Or is the project so much above them that they are just barely able to see that if they don't vote for it their job is lost. The truth is they have been voting against it all the time, but finally realize their own individual impotency.

The movement to improve our methods of doing things is shown to a certain extent by the movement now on foot to establish a national department of public works; perhaps there may be connected with this movement at some future time the idea of public service at cost.

During the last ten years I have employed a number of college graduates from a number of colleges and universities and while these men have had their faults, I have found it very difficult to lay my finger upon the faults which it would appear are in any special sense those due to the methods applied in their engineering education.

It seems to me that the principal faults which can be traced to their education are divided into two classes: (1) lack of capacity in the sense that a machine has capacity; (2) lack of general education.

Lack of capacity shows itself in measuring the ability to turn out a large output as in:

1. *Making Routine Reports.*—It was frequently observed that engineering students lack a knowledge of clerkship and a knowledge of the methods of securing accuracy. They frequently do not understand how to check a report so that all of the errors will be discovered and eliminated. Any high-grade clerk can do this. They lack a training in many of the duties required of a clerk.

2. *Surveys.*—Very frequently engineering graduates lack capacity of manipulation. It takes too long for them to do very simple things. They lack diplomacy in many cases. Diplomacy is very necessary when making a survey on foreign ground.

3. *Tests.*—Engineering graduates very frequently fail to produce satisfactory test results. The failure of capacity in this respect is very similar to the failure of capacity in clerkship and accuracy.

4. *Estimates.*—In many estimates it is frequently the case that graduates fail to evaluate and correctly weigh the data at hand.

5. *Designing.*—It is very frequently the case that young engineering graduates fail to distinguish the difference between what should be called correct engineering and what should be called individual judgment. This misconception is not confined to young college graduates. It is not safe to substitute the judgment of an individual for the criteria of correct engineering.

Lack of general education does not show itself merely as a lack of refinement and finish. It goes entirely to the root of fundamentals. Clear conception of ideas is an absolute necessity in engineering; I should say more so than in any other branch of activity. Probably nine-tenths of engineering knowledge comes through the study of the definitions and meanings of words. This applies not merely to technical words but to all kinds of words. I should say that the study of a science is largely a matter of arriving at a clear conception of the meanings of the words which have been employed by the teachers and writers in describing that science.

It is true that we seem to think that we have ideas of a science which are peculiarly our own individual ideas; and yet, we must admit that our own individuality in any particular line of activity consists principally in a display of individual energy rather than in an evolution of new modes of thought.

The engineer should study languages. It must be admitted, however, that he cannot take time to go into the details of languages to the same extent that should be required of a person contemplating a literary life. Perhaps one of the greatest fields for the engineering schools to develop is the proper method of instructing the students in the languages. It may not be amiss to suggest that the engineer should have as thorough an education in English as any other class of student, but that he should thereafter absorb the general nature of the other languages by actually reading and translating important technical articles on important subjects with which he is already familiar. Of course there should be a very brief and concentrated study of the simpler elements of contruction of some of the languages, but this should be merely an introduction, on the ground that a certain amount of such preparation is on the side of economy.

The student's ideas will be greatly broadened, and an immense amount of extremely valuable information will be acquired, by reading generally on important subjects such as law, economics, politics and finance. Such courses of reading should be supplemented by a course of lectures by real experts in the various branches.

These methods are bound to lead to general largeness covering all branches of engineering, and, indeed, will make the student at home in almost any society.

The lack of capacity in general education seems to result from a lack of breadth of courses and from too much time expended on small things. The student should be compelled to dig down to the merest detail in his studies at critical times. He should be trained to go to the ultimate degree of refinement in detail, but it is destructive of his mental development to keep him grinding on these details continuously.

Engineering students should not take too much vacation. Two weeks a year with the ordinary holiday vacations should be plenty. However the conditions are today, it is a fact that the most inefficient institutions we have had in the past have been our schools. An engineering school should be in daily operation the year around. It should keep in touch with its output of college graduates.

One of the best means for keeping in touch with the college graduate is to direct him in his early years toward proper lines of occupation and to advise with him as regards the salary he should expect and demand. One of the reasons why ordinary engineers fail to receive the compensation to which they are clearly entitled is because they do not know what their services are worth, nor do they know what they can demand. In most cases they do not even know what their fellow engineers are getting in the way of compensations and the custom has grown up to a large extent whereby each man has to pull for himself.

The question of discipline is extremely important; it is hardly necessary to go into this matter at the present time but it may be remarked that students frequently do not feel a proper sense of responsibility.

Whatever the conditions are today in our engineering colleges I can say that I was firmly convinced of the fact during fifteen years of college life, in which I acted as student in engineering, student in law, instructor in engineering physics, Assistant Professor and Professor, that there is too much formal class room work and too little time for independent thought and action. The tendency of this state of affairs is to rob the student of a certain kind of initiative force that ought to be developed fully.

I am inclined to think that there should be no formal class room work after the Sophomore year; that the student should work four hours each day in practical engineering and devote another four hours to reading and attendance upon high grade engineering lectures.

EDITORIAL.

The 1920 Meeting.—The twenty-seventh annual meeting of the Society will be held at the University of Michigan, June 29 to July 2. This date is necessitated by the fact that a number of institutions this year have late commencements. The Council has decided that the general topic for the meeting will be "Coöperation." President Greene is working on the program. One of the topics which received considerable attention at the Baltimore meeting was the relation between this Society and the technical engineering societies. This discussion at the Michigan meeting will be opened by President Ira N. Hollis, of Worcester Polytechnic Institute, the first president of the Engineering Council, on the topic "Coöperation with the National Engineering Societies." We all recall with pleasure his address on "Administration" at the Baltimore meeting. The question of coöperation between engineering schools and industries will be discussed by a number of men from industries.

The meeting this year should be rich in personal experiences since most institutions have made decided changes in their curricula and methods of teaching.

The new Alumni Hall of the University of Michigan, the recreation center of the university, will form the nucleus for all the social activities of the meeting.

The Engineering School at the University of Michigan has long been noted for certain excellent methods of instruction. The visiting members of the Society will have ample opportunity to study the work in detail. Dean Cooley and the members of the faculty of the School of Engineering, are entering energetically into the plans for the entertainment of the Society.

The Time of the Annual Meeting.—The attention of the members is called to the short note of President Howe appearing in this issue of ENGINEERING EDUCATION. It is suggested here for discussion and will come before the Society at the Michigan meeting for action.

Salaries of Engineers Engaged in Teaching.—The American Association of Engineers has created a committee to study the question of salaries of engineers engaged in teaching. Professor C. J. Tilden, of Sheffield Scientific School of Yale University, has accepted the chairmanship of this committee. All deans of engineering schools will be made corresponding members. A comprehensive study of the salary problem with recommendations will be made and these recommendations will be backed by the membership of the association.

TIME OF MEETING OF THE S. P. E. E.

For a number of years the meetings of the Society for the Promotion of Engineering Education have been held during the latter part of June or the first of July, after the colleges have closed. This meeting seriously interferes with the vacations of a number of members. As some scientific institutions close before the middle of June, those members of the faculty who expect to attend the Society meeting are obliged to defer their vacations for two or three weeks. As presidents and professors are pretty tired by the end of the college year, it would seem to me advisable to hold the meetings at some other time. Why would it not be better to hold them during the college year and let the time taken for them come out of that period rather than come out of the vacation, which provides a time of rest so badly needed by all connected with engineering colleges? I would like to suggest that this question be seriously considered by the board of directors and if they should deem it wise, that a vote of the membership, or at least that part of the membership which attends the meetings, be obtained.

Charles S. Howe,
President,
Case School of Applied Science.

Feb. 18, 1920.

COOPERATION BETWEEN ENGINEERING COLLEGES AND INDUSTRIES.

BY ERNST J. BERG.

Three methods of coöperation between engineering colleges and industries may be feasible. The first involves short periods of alternating work between the college and the factory. The second, involves periods of longer duration—a month or so—and the third, continuous work at the college, during the college year and properly arranged work during the summer vacation at the factory.

The first alternative has been given a very fair trial by Union College. During the last semester of the senior year the electrical engineering class was divided into two sections which spent alternate weeks at the college and at the General Electric Company's shops.

Not only the college was anxious that the trial should be fair but the General Electric authorities were equally interested and went to considerable trouble to see that the students were given practical testing experience on the particular phase of engineering which was dealt with each week in the classrooms. The students were also anxious for the experiment, indeed enthusiastic to try it. To them it meant not only the possibility of better education but also financial help directly, and indirectly to those that decided to stay with the company at the end of the college course.

At the conclusion of the semester each student was backed to write his opinion about the experiment. The replies were very interesting. In every case the student appreciated that he had learned a great deal that he otherwise would have missed but believed decidedly that the time could have been better spent entirely at the college. The faculty reached the same conclusion, and felt that the result would have been very much the same if the periods had been longer.

As a consequence Union College has adopted the third alternative. Engineering students are given opportunity to get properly planned work at the General Electric Factories during vacations.

CULTURE.*

The little college town of Umphburg was ablaze with color. It was autumn and the afternoon sun shone on fluttering pennants and bunting of varied hue that bedecked the palatial structure of the University of Umph.

Today was the day of all days—the day of the annual gridiron struggle between Umph and Shooch.

The million-dollar stadium gleamed in the autumn sun while thousands of students and alumni crowded through the gates to their seats at $20 the seat.

Inside the gridiron gladiators were listening to final instructions from their $500,000-a-year coaches.

On the curb outside the marble gateway was a line of ragged, wretched old men raising their piteous voices in their endeavor to eke out an existence by the sale of peanuts, pennants and chewing gum.

"Who," asked a stranger, "Who are those human derelicts? Who are those unfortunate creatures casting a blight on these noble surroundings? Who are those hopeless wrecks starving in the midst of plenty?"

"Them?" replied a freshman, "Them's our professors."

NECROLOGY.

F. L. EMORY.

Professor F. L. Emory was born in Dunenburg, Mass., April 9, 1867, the son of Edward Franklin and Mary Mildred Emory. He received his common school education there and attended college at Worcester, Mass., receiving a bachelor's degree in mechanical engineering in 1887. He was director of the mechanical and manual training department of Washington, D. C., high school 1887–89. He established and superintended the Trades School in the Massachusetts Reformatory 1890–91 at Concord Junction, Mass.

---

* *The Pittsburgh Post*, February 24, 1920.

In the fall of 1891, he was selected by the late Dr. Eli Marsh Turner, then president of West Virginia University, to establish and take charge of the new department of mechanical engineering of West Virginia University organized that year under the provisions of the Morrill Act of congress. This he did most successfully, constructing the first mechanical hall on the site now occupied by the university heating plant. From 1892–95, he was engaged in establishing and directing the Industrial Training and Technical High School for the city of Indianapolis, Ind. He built and equipped this modern school to accommodate 1,200 pupils.

In the fall of 1895, he entered Cornell University to take postgraduate work and received a master of mechanical engineering degree from that institution in 1896. He then returned to West Virginia University to become professor of mechanics and applied mathematics, which position he held at the time of his death. In 1899, his alma mater, Worcester Polytechnic Institute, conferred on him the degree of master of engineering.

In addition to his teaching duties Professor Emory was for a number of years superintendent of grounds and buildings at the university and as such had charge of the construction of the armory, Mechanical Hall, Library, president's house and central heating plant of the university.

During his incumbency as a professor of the engineering faculty, Professor Emory made a most exhaustive study of the early history of the steam engine and steam engineering and at the time of his death, had perhaps the most complete collection of lantern slides on this subject in the United States. As chairman of the faculty committee in charge of the University Engineering Society, he accomplished most valuable work, for it was here that he devoted particular attention to stimulating research by the advanced engineering students, and at the same time encouraged the development of forensic ability through papers and addresses which he had them prepare and read before the society.

With Dr. Frederick Truscott, of this city, he was co-author in the translation and publication of the "Philosophical Essay on Probabilities" by Laplace, in 1902, often referred to as the treatise on "Least Squares." More recently, he had completed a manuscript on "Strength of Materials" which was ready for the printer's hands. He had also written many papers for various scientific societies of which he was a member. He held membership in the American Society of Mechanical Engineers, and the Society for the Promotion of Engineering Education. He also served as a member of the board of school commissioners for Morgantown Independent school district, for a number of years. Professor Emory has been a member of the Society for the Promotion of Engineering Education since 1894.

LESLIE H. HARRIS.

Professor Leslie H. Harris died February 21, aged thirty-six years. He was born October 23, 1883, at Bradford, Pa. Together with his father and brother he spent his early life in the oil fields of the Middle West. In this work he was early impressed with the need of an engineering education in order to be better fitted for the industrial life of the day. He entered Purdue University in 1903, graduating with the degree of bachelor of science in electrical engineering in 1907.

While at Purdue, Professor Harris developed a keen interest in military science and tactics. This type of work was second only to his engineering pursuits. He rose to the rank of colonel in command of the Cadet organization. This military experience obtained at Purdue was responsible for his active participation in military matters during the late war. Upon completion of his work at Purdue, Professor Harris entered the employ of the Westinghouse Electric and Manufacturing

Company at East Pittsburgh in September. After working with this company for a short time, he received a call from the Western University of Pennsylvania to take up the work in the Department of Electrical Engineering. A year after entering the Western University, the entire institution was moved from its former location on the Northside to the Schenley Farms district where the School of Engineering occupies the new and modern engineering building made possible by public subscriptions.

This change gave Professor Harris an excellent opportunity to work out some new ideas in connection with the training of electrical engineering students. It is sufficient to say that many of his original ideas are not only still in use in this institution, but have been adopted by a number of other engineering schools. He was gradually advanced from instructor until in 1915 he was made professor and head of the Department of Electrical Engineering.

Another event occurred shortly before this time which was instrumental in shaping his future career. The Commonwealth of Pennsylvania decided to form a public service commission and in order to properly standardize their engineering plans, the committee retained Professor Harris in the capacity of consulting engineer for the creation of their early rules and regulations. Professor Harris continued in the capacity of consulting engineer to the Commission throughout his connection with the University of Pittsburgh. Preceding the completion of the standardizing laboratory at Harrisburg, Professor Harris conducted all standardizing work for the State in the laboratories of the School of Engineering. His services continued to be more and more valuable to the Commission and, as a result, he resigned from the School of Engineering of the University of Pittsburgh, effective February 1, 1920, tó take up continuous work as Division Engineer in the Public Service Commission in charge of the valuation work.

Military matters were one of Professor Harris's most interesting side issues and during the work of the Engineering

School in summer camp at Windber, he had charge of the military organization. This work was carried on during the summer of 1917, when America was beginning to take active participation in the world war. In this capacity, Professor Harris prepared a number of students for a successful military career during the next two years.

Being a member of the Reserve Officers' Training Corps at the time, he was called into service in August of that year. He went to Washington, but was later transferred to Camp Stuart at Newport News with the rank of major and the title of Port Utility Officer, having charge of the construction and embarkation camp located there.

Professor Harris was married on September 3, 1914, to Alma Kerr of the Northside. Mrs. Harris contracted pneumonia and died February 8, 1920. They leave one daughter, Alma Louise, aged four years.

Professor Harris was a member of the Eta Kappa Nu, Tau Beta Pi, and Delta Epsilon, being National Secretary of Eta Kappa Nu. He was also a member of the American Institution of Electrical Engineers, the Engineers Club of Harrisburg, and the Society for the Promotion of Engineering Education, having been assistant secretary of the latter from 1914 till he entered service. He was a member of the Society since 1912.

R. C. MACLAURIN.

Dr. Richard Cockburn Maclaurin, since 1908 president of Massachusetts Institute of Technology, died at his home in Cambridge, Mass., January 15. He succumbed to pneumonia in the prime of a remarkably constructive life devoted to higher education, being only fifty years old at the time of his death. That he had received the Cambridge University degrees of Sc.D. at the age of twenty-eight, LL.D. at thirty-four, and became president of Massachusetts Institute of Technology at thirty-eight is evidence of his versatility and brilliance. His

---

* *Engineering News Record,* Vol. 84, No. 4.

ability as an organizer, financier, and developer of educational institutions was no less remarkable than his attainments in science and law.

Richard Cockburn Maclaurin was born in Lindean, Scotland, in 1870. His early boyhood was spent in New Zealand, whence he returned to England to complete his preliminary education. In 1892 he entered the University of Cambridge, where he held a foundation scholarship in St. John's College. He took two degrees at Cambridge, B.A. and M.A., the thesis work for the latter being advanced mathematics. He received the Smith prize for excellence in mathematics, and upon graduation was elected Fellow of St. John's College.

Leaving Cambridge, Dr. Maclaurin next spent ten months in the United States and Canada (1896–97) studying and visiting educational institutions and spending much time at McGill (Toronto) and Leland Stanford universities. Returning to England he re-entered Cambridge, this time to study law, and was awarded the McMahon law studentship, the most highly valued of its kind in the university.

In 1898 Dr. Maclaurin was appointed professor of mathematics in the University of New Zealand, became a trustee of the university, and took an active part in the organization of technical education in that colony. He became dean of the faculty of law in the university in 1903 and continued in that capacity for the next four years. In 1898 Cambridge University honored him with the degree of doctor of science and again in 1904 with the degree of doctor of law.

He was invited to take the chair of mathematical physics at Columbia University, New York City, in 1907, and a year later was made head of the Department of Physics. Dr. Maclaurin was appointed president of Massachusetts Institute of Technology, November 23, 1908, succeeding Henry S. Pritchett, who had retired to become chairman of the Carnegie Foundation. At that time Massachusetts Institute of Technology had reached the limit of its facilities and still fell far short of fully carrying out the plans of its founders. Its buildings, equipment and funds were only a fraction of its needs. Dr. Maclaurin undertook to make up the deficiencies.

First he unified the corporation and the faculty, and by his personality gained the confidence of the alumni and bound them as never before into a great force working for the benefit of their alma mater. One of the first fruits of his efforts was the gift of T. Coleman du Pont of half a million dollars toward the purchase of a new site for Technology at Cambridge. The corporation at the same time made up another quarter-million which completely paid for the land. Following this, with the aid of the alumni, he secured the passage of a Massachusetts act granting additional funds for the support of the school.

When the site question was settled it was necessary to procure enormous sums for the construction and maintenance of plant, and with the enthusiastic support of the alumni Dr. Maclaurin undertook to raise them. First came the gift of $2,500,000 from George Eastman, of Rochester, N. Y., which was closely followed by other gifts in sufficient measure to warrant the beginning of construction. Subsequent gifts from Mr. Eastman, made before 1919, amounted to $4,500,000, and finally, only a few months ago, was made his offer of $4,000,000 contingent upon the raising of an additional $8,000,000 for proper financing of the institute. At an alumni dinner in Boston, January 10, it was announced that the $8,000,000 had been made up, that Mr. Eastman had made good his $4,000,000 promise and that the Massachusetts Institute of Technology now has an additional endowment of $12,000,000.

Dr. Maclaurin must be directly credited with the creation of the organization and the spirit which made possible the surpassing facilities for technical education now possessed by the institution whose affairs he so ably guided.

President Maclaurin was a member of the Society for the Promotion of Engineering Education since 1909.

COLLEGE NOTES.

The University of Minnesota.—C. M. Jansky, Jr., was recently appointed an instructor in electrical engineering at the University of Minnesota, to specialize in radio and transients. Mr. Jansky is a graduate of the University of Wisconsin. He has had teaching experience in the Army Training Schools and in the University of Wisconsin, following several months of research work on military intelligence problems at the Western Electric laboratories in New York City, which were continued at Madison. He collaborated with his father, C. M. Jansky, in writing a text-book on "Radio Telegraphy." At the University of Minnesota, his work will include courses with the Signal Corps Unit of the R. O. T. C. and also with other advanced students.

The College of Engineering at the University of Minnesota, like similar institutions, is overwhelmed this year with an unprecedented increase in the number of students. The registration this year is about 1,150 students in engineering and architecture of whom 625 are freshmen.

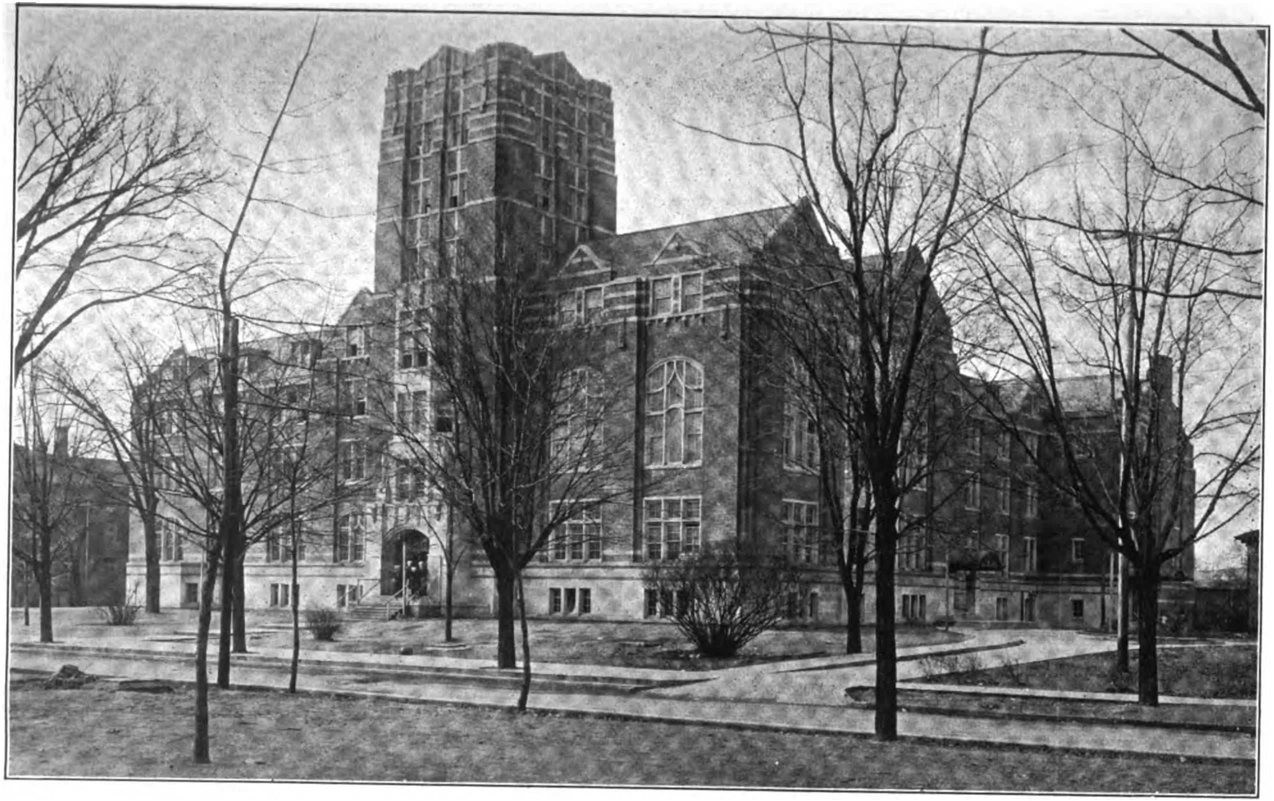
The prospects are good for the construction of the new Electrical Engineering Building in the very near future.

University of Pennsylvania.—Mr. Chas. D. Fawcett, recently appointed assistant professor of electrical engineering at the University of Pennsylvania, graduated from the University of Colorado in 1911, following which he served as instructor at that institution for one year. For two years he worked in the testing department of the General Electric Company, and also in the research section of the transformer department. For several years he served as instructor in electrical engineering at the University of Pennsylvania, and in 1916 was appointed Assistant Secretary of the Illuminating Engineering Society with headquarters in New York.

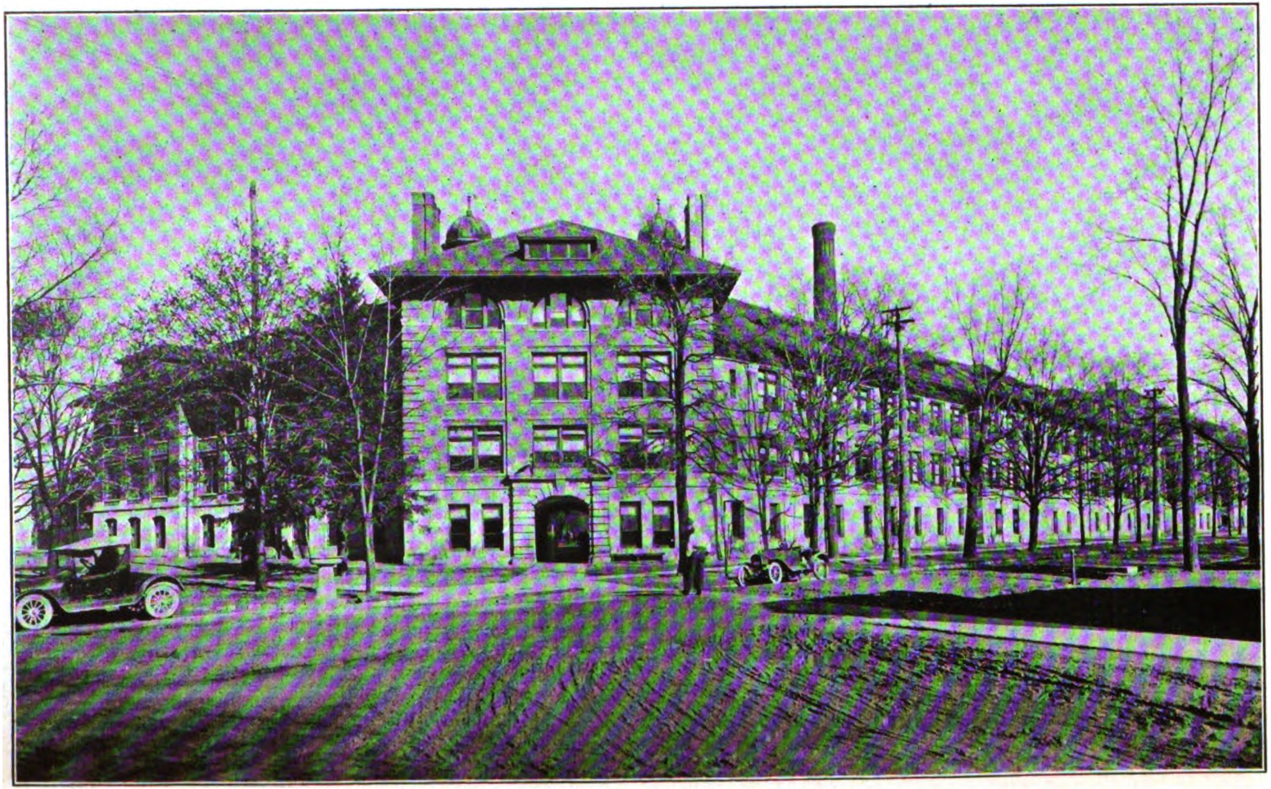
Mr. H. R. West, recently appointed instructor in the Electrical Engineering Department at the University of Pennsylvania, is a graduate of the University of South Dakota with the degree of A.B. in 1915 and that of M.A. in 1916.

From July to December, 1917, Mr. West was employed in the transmission engineering department of the Bell Telephone Company of Pennsylvania, and from December, 1917, to June, 1918, served in the operation and maintenance department of the Hog Island Shipyard. From June, 1918, to March, 1919, he was engaged on submarine detection work as an Ensign in the Navy, being detailed to the Naval Experimental Station at New London, Conn.

Mr. Walter J. Seeley, recently appointed to an instructorship in electrical engineering at the University of Pennsylvania, is a graduate of the Polytechnic Institute of Brooklyn, in the class of 1917. For two years following his graduation, Mr. Seeley was engaged in research and development work on submarine detection as an ensign in the Navy, at New London, Conn., and at Plymouth, England.



Michigan Union Club House.



New Engineering Building.

BULLETIN

OF THE

Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee:

Arthur M. Greene, Jr., John F. Hayford, F. L. Bishop, *Editor*.

Address all communications to the Editor, University of Pittsburgh, Pittsburgh, Pa.

VOL. X LANCASTER, PA., APRIL, 1920 No. 8

TABLE OF CONTENTS.

Points of General Interest at the University of Michigan. J. Raleigh Nelson 345
The Classics for Engineers. Evan T. Sage 364
Editorial 371
Information Desired 372
Report of Treasurer 372

POINTS OF GENERAL INTEREST AT THE UNIVERSITY OF MICHIGAN.

BY J. RALEIGH NELSON,

Associate Professor of English.

The meeting of the S. P. E. E. to be held in Ann Arbor, June 29 to July 2, will give the members of that society interested in the development of state universities, an opportunity to see the University of Michigan at a most significant moment in its history. President Harry B. Hutchins, the able successor of President Angell, will have closed his period of service and given his valedictory at the commencement exercises the week preceding our meeting and President Burton will have been installed in his new office less than a week. The ten years of President Hutchins's administration has been a period of rapid growth, not only of the student body but especially in material equipment. President Hutchins, who was the first of Michigan's own graduates to act as president, has been strikingly successful in consolidating the great body of alumni and inspiring them with a vision of their opportunity for serving their alma mater. During his ten years of service, the alumni have given at least $2,000,000 in cash and property estimated at $1,000,000 more. These gifts include the Alumni Memorial Building, the Hill Auditorium, the Martha Cook and the Betsy Barber Residence Halls for Women. There was, in addition, the achievement of the Michigan Union Building, a gift of over $1,000,000 contributed by over thirteen thousand alumni, whose largest gift was $10,000—a tribute to their love for the great President James B. Angell, to whose memory it was dedicated. Lately, too, have come large gifts for the less material but no less essential, scholarships, as, for example, the gift of $200,000 worth of Detroit property by Regent G. D. Barbour for the Education of Oriental Women. President Hutchins's insistence on the building up of material equipment has, in the light of the enormous growth in enrollment of the past two years, been almost prophetic. At least, it has shown how well he understood the needs of the University. Fortunately, too, he was practically always successful with the Legislature of the State in inspiring confidence in his judgment. What he asked for they gave.

Some of the most important buildings erected during his administration are: the Library, Hill Auditorium, Power House, Contagious Hospital, Science Building, Homœopathic Children's Ward, Newberry, Martha Cook, and Betsy Barbour Residences. Altogether the building equipment added since 1910 aggregates approximately two million, four hundred and fifty thousand dollars. To his credit should also be given the completion of the Union Building costing over a million more.

At the very close of his administration, the Legislature voted $2,200,000, which will make possible the new Model Training School and the $1,850,000 hospital already in process of construction.

Members of the S. P. E. E. who visit Ann Arbor in June, therefore, will find Michigan in the midst of a pretentious building program, enough of which has been already realized to make the lines of development for the future rather evident. Some of the buildings in which visiting members may be interested are as follows:

ENGINEERING BUILDING.

The New Engineering Building is, with the exception of the Science Building and the Library, the largest building on the campus. The total floor-space is 144,444 square feet. It forms with the engineering shops the two sides of the Engineering Quadrangle. In addition to class rooms, it contains lecture rooms, administrative offices, the naval testing tank, the special laboratories for mechanical and electrical engineering, the automobile, hydro-electric, and physical testing laboratories. Although the building was erected as recently as 1902, and was later largely extended, the engineering college has already so completely outgrown it that a very large extension is planned for the near future.

CHEMISTRY BUILDING.

The chemistry building provides for the teaching of chemistry to students in all of the various departments of the university and for the technical work in the school of pharmacy and the course in chemical engineering. The whole of an admirably designed, strictly fireproof building erected in 1909 at a cost slightly over $300,000 is devoted to those purposes. The building is rectangular in shape, 230 × 130 feet, with two central courts, and is four stories high. It contains

125 rooms and has a total floor area of 104,500 square feet. The exterior was designed to give a maximum amount of window space and artificial illumination by tungsten lamps has been installed on an equally generous scale. Ventilation is cared for by eight fans capable of changing the air in the entire building every eight minutes, and the heating is controlled by thermostats in each room. The hood facilities are excellent. Hydrogen sulphide, high pressure steam, compressed air, and distilled water as piped to the laboratories needing them, and special electric circuits have been freely provided. The storerooms occupy a stack six stories high, including basement and attic, placed in the central crossbar of the building, with provisions for dispensing on three main floors.

The library occupies the center of the south side of the building and is a handsomely finished room with shelf capacity for ten thousand books and seats for 85 readers. The chemical library contains 8,400 volumes and is especially rich in complete sets of journals. One hundred and eleven journals are currently received. The chemical museums on the third floor contain valuable exhibits illustrating chemical manufacturing processes.

In addition to a full supply of routine materials and apparatus for work in general, analytical, organic, physical, pharmaceutical and technological chemistry, facilities are offered for advanced study along all of these lines.

NATURAL SCIENCE BUILDING.

The natural science building is a four-story fire-proof building erected in 1915 at an expense of $375,000 for the use of the departments of botany, forestry, geology, mineralogy, psychology and zoölogy. The approximate measurements are for the north side 243 feet, for the east side 263 feet, for the west side 150 feet; and the south side, with a series of breaks, is made to conform in general to the diagonal walk and trees. A greenhouse is located on the south side at the east corner.

The building encloses a court 120 feet across. A corridor about 700 feet in length runs through the center of each floor. There is a clear span of approximately 23 feet between the corridor and the exterior walls on both the campus and court sides. The total capacity is approximately 155,000 square feet of space. The form of construction gives unusually large windows, and these combined with the light court in the center allow excellent illumination of all rooms. The corridor floors are finished with terrazzo, the floors of the rooms with cement. The building contains 270 rooms. Each department is given a section from roof to basement. At the southwest corner on the diagonal walk is located a lecture room seating 500, with a preparation room attached. The lecture table is built in sections; each section runs on rollers and can be taken to any part of the building for the preparation of material. These sections fasten to stanchions set in the concrete floor; at the stanchions all sorts of plumbing and electric supplies are available, including low-voltage storage-battery current. An isolated and well-lighted library for all departments in the building is located above the lecture room. This portion of the building is carried on structural steel.

There is a vacuum cleaning system throughout. Alternating current is used for power and for lighting and is available everywhere. There is a unit system of distribution of direct current at 220 volts and special outlets for direct current at 75 volts are well distributed. The building is well ventilated with complete air supply and exhaust system. A special separate exhaust is provided for the toilets and certain other rooms. Pneumatic switches and diaphragm motors are used to control ventilation. The temperature is controlled by thermostats.

THE OBSERVATORY.

The university observatory was founded in 1852, through the liberality of citizens of Detroit, and is known as the Detroit Observatory. It is situated half a mile northwest of the university campus. The observatory has recently been remodeled and contains a new telescope and dome, which cost about $35,000. The instrument is a reflecting telescope with a 37⅝ inch parabolic mirror. In its light-gathering power this telescope is in a class with the Lick and Yerkes refractors, while for ordinary astronomical photography it is at least as efficient as those instruments. The brick tower and copper covered dome rises sixty feet from the basement floor and is forty feet in diameter. A two-story brick addition, 112 feet long and 40 feet wide, connects the new dome and the old observatory and contains offices, class, and computing rooms.

THE UNIVERSITY POWER PLANT.

The new university power plant, which cost $350,000, is a fine example of modern power-plant construction and is available for instruction and for use. It is proposed in the future to obtain a supply of water from the river by means of an electrically operated pumping station erected near the river. The feed-water heaters supply hot water to the boilers and also for domestic purposes. Coal is brought directly from the Michigan Central Railroad to the plan over an electrically operated road, delivering the coal to a storage bin, whence it is taken by a coal-crusher and delivered to the steel bunker above the stoker-hoppers. The ashes are carried by a pneumatic conveyor to a bunker over the track, from which they are loaded directly into cars. Tunnels are provided for the underground distribution of steam, hot water, and electrical energy. There is available alternating current at 2,300 volts, 320 volts for lighting, and other voltages for power; also direct current at 220 volts and 500 volts; high and low-pressure steam, and hot water.

HILL AUDITORIUM.

The Auditorium, erected as a memorial to the late Regent Arthur Hill, of Saginaw, who left the sum of $200,000 to the university for that purpose, was formally dedicated Wednesday, June 25, 1913. The building has a seating capacity of nearly 5,000, which makes it one of the largest concert and lecture halls in the world. Particular attention has been paid to acoustic properties, and the fine concerts of the May Festival seasons have proven that this difficult problem has been almost perfectly solved. There is no seat where one is not able to hear with the greatest ease. The building is finished in tapestry brick and terra cotta. It contains, in addition to the great auditorium, a number of offices and check room dressing rooms for the choruses, and a great hall on the second floor, about the walls of which the Stearns Musical Collection, containing 1,400 instruments, has been placed. It also contains the Frieze Memorial Organ. The building was erected at a cost of $285,000.

ALUMNI MEMORIAL BUILDING.

The Alumni Memorial Building, which is on the southeast corner of the campus, was built from subscriptions made largely by members of the Alumni Association as a memorial to the distinguished alumni of the university who have served the country in war and in peace. The total cost was about $200,000. It is the headquarters of the Alumni Association and contains as well the art collections of the university. It was dedicated May 11, 1910, with an address by the Hon. Curtis Guild, of Massachusetts, and was opened in May, 1910, with an exhibition of Oriental and American art under the charge of the Hon. Charles L. Freer, of Detroit, from whose collection many of the pictures came.

THE NEW LIBRARY.

The new library building of the University of Michigan was formally opened on January 7, 1920. It cost, with its equipment, $615,000. The architect was Albert Kahn, of Detroit, the designers of the Hill Auditorium and the Natural Science Building. It is 177 feet in breadth, 200 feet in depth, and is four stories high. The old book stacks which were incorporated in the new building are five stories, the new ones eight stories high, and are so built that they may be extended to fifteen. There are seats in the new structure for one thousand readers, distributed among the reading and study rooms, seminars, and stacks. It will house one million volumes without extension, and nearly a million more with the extensions planned for. The reading room, a noble room, 170 feet long, 50 feet wide, and 50 feet high, in the center of the barrel-vaulted ceiling, will seat 300 readers. While everything has been subordinated to utility in the building, the artistic features are well worth noting. The paintings by Gari Melchers in the reading room, the stained glass windows, the casts of the Della Robbia Choir, and the Parthenon frieze, the panels by Thomas di Lorenzo are all worthy of the noble building of which they are a part.

Points of Specific Interest to Engineers.

As educators, the visiting body of the S. P. E. E. will, we are sure, be interested to observe the university at this time when it is coming out into a new era of material prosperity. But naturally as engineering educators most of our visitors will find their particular interest in those things which affect the engineering profession and engineering education. They will find the engineering college rapidly outgrowing its accommodations on the campus and planning hopefully for great and significant expansion in the near future. More significant still, they will find the engineering college in the midst of a thorough reorganization of its courses of study along broader and more distinctly fundamental lines. They will be interested, too, to learn of the plans for a closer cooperative relation between the college of engineering and the industrial interests in the state. The faculty of the college, fully alive to the significance of the changes which must soon come, and soberly aware of the problems involved, look forward to the coming of so influential a body of educators as the S. P. E. E. as a great source of inspiration and guidance.

We shall hope to afford our visitors in return every opportunity to see any of the things of interest to them which may be a part of our own material equipment or may be made available by our proximity to great engineering centers like Detroit, Toledo, and Jackson.

Some of the points of interest in our own college are as follows:

SANITARY EXPERIMENT STATION.

The sanitary experiment station, located immediately north of the general hospital, is well worth a visit from those interested in a plant which handles large volumes of sewage, and which shows what can be done in the installation of effective teaching and research equipment at moderate cost. One of the city sewers is carried to the station, where sewage disposal plants have been in operation constantly under skilled supervision for the past six years. A septic tank, an Imhoff tank, trickling filters, sand filters, and contact filters have been and are in constant operation.

HIGHWAY LABORATORY.

The highway laboratory is temporarily installed in the north half of the old campus power house. It is the official laboratory of the Michigan State Highway Department. Equipment is installed for all standard tests of brick, stone, gravel, bituminous materials, cement and for soil analysis in connection with sand-clay and earth roads. There is most complete coöperation between the State Highway Department and the university, the testing work for the state and the road materials survey of the state being under charge of Professor J. H. Bateman.

One very interesting feature of the highway work is the series of short period, intensive courses in highway engineering and economics of highways conducted as graduate courses between December 1 and March 15, each year under the direction of Professor Arthur H. Blanchard.

STEAM LABORATORY.

The steam laboratory, which is located in the north end of the engineering building occupies a floor space of some 13,000 square feet. It is devoted to experimental work in connection with the testing of engines, boilers, pumps, fans, air compressors, refrigerating machinery, gas and gasolene engines. The very complete and modern central power and heating plant of the university located on Washington Street is also used for the laboratory tests.

HYDRO-MECHANICAL LABORATORY.

The hydro-mechanical laboratory, which is located in the north end of the engineering building, is equipped with a pair of tanks each having a capacity of 600 cubic feet. These are mounted on large scales, making it possible to weigh accurately all the water from a 1,000,000 gallon pump. There are also water wheels and centrifugal pumps of different types. As this laboratory is connected through a canal with the large ship tank it is possible to draw from a large water supply when conducting experiments.

In addition to the hydro-mechanical laboratory in the engineering building, there is a flume for the measurement of large volumes of water, installed as part of the Argo Dam on the Huron River. There are five hydro-electric plants on the river within a few miles of Ann Arbor, a very complete gaging station at which various types of self-registering gages are installed and other features of interest. Michigan is a water-power state. There are many large plants in operation and over one hundred small low-head powers. Engineers interested in this subject may secure data from Professors H. W. King and C. O. Wisler.

THE AUTOMOBILE LABORATORY.

The automobile laboratory is located north of the engineering building. In the same building and just south of the automobile laboratory will be found the space ready to receive the tractor laboratory recently donated by the Cleveland Tractor Co., of Cleveland, Ohio. The automobile laboratory consists of an engine-testing section, a dynamometer room and a section for the display and demonstration of automobiles, motor trucks and their component parts. The engineer testing section contains a complete equipment of engines, selected with a view to affording the student experience with various typical successful types. This section is equipped with prony brakes, water dynamometers and one fan dynamometer. The dynamometer room contains a complete Diehl electric dynamometer, together with special fuel measuring devices, tachometers, air meters, pyrometers, gas analysis apparatus, manograph, and complete accessories necessary for instructional testing and advance research work. In the display and demonstration section are gathered together complete operating and cut-out chasses, various types of engineers, cut-out transmissions, rear axles, differentials, clutches, carburetors, ignition systems and other automobile parts and equipment. This apparatus is especially mounted to show its operation and design and is used as demonstration study, and test equipment for the regular automobile courses. It further serves as a permanent educational exhibit open to the public.

EXPERIMENTAL SHIP TANK.

The experimental ship tank, 300 feet long, 22 feet wide, and 10 feet deep forms the basement of the east wing of the new engineering building. Its capacity is 16,000 barrels. In this tank are tested paraffine models of boats of various sizes, which are prepared in the model room and workshop at the north end. The only other tank of this kind in the United States is at the Washington Navy Yard. The facilities offered by this tank were used extensively by the government during the war. It may be of interest to note that Michigan was the first school to offer systematic courses in marine engineering. Professor Cooley, who was an Annapolis man, gave two courses in ship building and marine engineering from the first of his connection with the college. The regular department of marine engineering was organized in 1900.

ENGINEERING SHOPS.

The engineering shops occupy about 30,000 square feet of floor space. They consist of the wood and pattern shop, the foundry, the forge shop, and the machine shop and instrument shop with the usual equipment. The newly instituted central shop is of some special interest, as it gives promise of great usefulness to the university at large. It is intended to give the required service to all departments of the university requiring the making of instruments or any general repair work. The shop, which at present has only six machines, will by June be fully equipped. Both in fitting out this shop and in obtaining more modern tools for purposes of instruction, the university has taken advantage of the opportunity afforded by the Caldwell Bill for obtaining machine tools from the Government Salvage Board.

ELECTRICAL ENGINEERING LABORATORIES.

The electrical engineering laboratories comprise a dynamo laboratory and a photometric laboratory located on the ground floor of the north end of the new engineering building and the communication laboratories on the ground floor of the south end of the same building.

The terminals of almost every piece of apparatus in all these laboratories have been brought out to sockets, and the distribution of power is controlled through a plug and socket system. This arrangement gives great flexibility and requires that all connections be made by the student himself, but provides the means by which those operations may be quickly and easily performed.

The dynamo laboratory contains a full complement of direct and alternating current apparatus of various types and sizes. As in all of the electrical laboratory work, special emphasis is here laid upon the development of the student's ability to analyze the phenomena which he observes in the operation of electrical machinery. To this end, and with the aim of developing the personal initiative of the student, a large number of moderate-sized machines have been provided in order to give each student intimate contact with the apparatus.

The laboratory has on exhibit several dynamos of very early type which are of historic interest.

The photometric laboratory is equipped with four fixed photometer bars, one of them for precision work, all provided with suitable auxiliary devices. There are also three portable photometers for making illumination surveys in the field. A single-mirror selector permits of measurements on large light sources. The laboratory has a complete and modern collection of lamps and accessories including mercury, magnetite, and flame carbon arcs, refractors, reflectors of all varieties in glass and metal, and a floor light projector.

The communication laboratories which are equipped for fundamental work in telephone, telegraph, and radio communication have all the usual talking, signaling, and testing apparatus. In addition, it is equipped with a Vreeland Sine Wave Oscillator having a frequency range of 250 to 4,000 cycles per second. This apparatus in connection with a 50-mile artificial line arranged so that it can be used either as a loaded or non-loaded cable, affords an opportunity for making a fundamental study of transmission phenomena at voice frequencies.

For special studies a small magneto exchange and a small automatic exchange are available. The university private branch exchange which is adjacent to the laboratories, is also available for inspection and special studies.

In the radio laboratory the old pioneer rotary spark transmitting set is still in service. The more modern types of transmitting and receiving apparatus are furnished largely by the Signal Corps of the United States Army.

Physical Testing Laboratory.

The physical testing laboratory occupies two adjoining rooms, 29 × 54 feet and 27 × 54 feet respectively, on the ground floor of the south wing of the building, and is equipped with apparatus especially designed for testing the strength of materials used in engineering work. This equipment includes a 100,000 pound Olsen testing machine and one of 200,000 pounds capacity built by Riehle Brothers. Both of these machines are adapted to tensile, compressive and transverse tests, and are run by direct-connected electric motors. An Olsen torsion machine of 240,000 inch-pounds capacity, also equipped with direct-connected motor, is used in determining the torsional strength of shafts and axles. Impact tests are made on an Olsen impact machine, and Upton Lewis toughness testing machine is used for endurance tests. The cement-testing laboratory is equipped for making the ordinary tests of cement and concrete. In addition to scales, sieves, briquet molds and accessories, there are two briquet testing machines made by Olsen, and a uniform load beam testing machine, especially designed for the University of Michigan with a capacity of 85 tons, and adapted to beams of reinforced concrete, wood, or steel of any span up to 12 feet.

Chemical Engineering Laboratories.

The chemical engineering laboratories occupy twenty-five rooms on the first and second floors of the chemistry building. The gas and fuel laboratory includes: (1) a general laboratory for gas analysis; (2) a calorimeter room equipped with ten bomb calorimeters; (3) a large and well-ventilated photometer room with an excellent photometer supplied with several types of standard lights and test burners; (4) an instructor's laboratory; and a laboratory for advanced students.

The assay laboratory comprises an ore-crushing and sampling room with modern equipment, a room for the preparation of assay charges, a balance room and a number of assay furnaces.

The furnace rooms, the pyrometer room and the metallographic, the paint and varnish, and the pulp and paper laboratories are all thoroughly supplied with modern equipment and are well worth a visit of inspection by those interested.

The evaporator laboratory is of particular interest since it represents a successful experiment on the part of the university in the establishment of coöperative relations with the industries of the state.

On May 19, 1917, an offer was made to the university by the Swenson Evaporator Company to install and equip a laboratory for the study of the design of evaporators and similar problems in chemical engineering. The plan was discussed at considerable length by the board of regents, as certain new principles were involved, and the offer was finally accepted by them on July 20, 1917.

Work was started in October, 1917, to prepare the old boiler house for the laboratory. Because of war conditions only one evaporator was installed at first, and that not till the spring of 1918. Two more followed in the spring of 1919, and the various pieces of accessory apparatus at different times. The amount expended by the Swenson Evaporator Company for apparatus and erection, exclusive of research or operation, is to date between $15,000 and $20,000.

By the terms of the agreement the apparatus, once installed, is the property of the university. It is available before everything else for university work, instruction, demonstration, and research. The Swenson Evaporator Company has the privilege of doing their own research work, provided it does not conflict with the university's work, with the reservation that any fundamental principles discovered or data of general scientific importance obtained are public property even if the work was done by the company.

In the time since the apparatus was installed both classes of work have been carried out. Several chemical engineering students, graduate and undergraduate, have taken work in the laboratory every semester. The Swenson Evaporator

Company has been developing a very extensive program of research, most of which will be available for publication. One paper representing nearly the whole of one year's work by the company, will be published in the spring of 1920. Less than 15 per cent. of the work done by the company has been detail work for their own private information.

Camp Davis.

In 1908 and 1909 the regents of the university came into possession of about 1,600 acres in Cheboygan County, Michigan. A part of this came as a gift from Colonel Charles Bogardus and his wife, Hannah W. Bogardus. Since 1909 the regents have purchased, from time to time, other tracts until they now have in their possession an area of about 3,200 acres. In recognition of the kindly interest of Colonel Bogardus and his wife, the entire area now owned by the university is called the Bogardus Tract. The surveying camp, situated on these lands, is known as Camp Davis, in recognition of Joseph Baker Davis, who established the camp in 1874 and conducted it for over thirty years, many years before any other university followed the example thus set by Michigan. The university lands lie, generally speaking, between Douglas and Burt Lakes, having a frontage of four and one half miles on the former and one and three fourths miles on the latter lake. The camp is six miles east of Pellston on the G. R. & I. Railroad, eight miles northwest of Topinabee on the Michigan Central Railroad and thirteen miles southwest of Cheboygan. Camp Davis is located on the south shore of South Fishtail Bay, Douglas Lake. The quarters of the students, teaching staff, physician, store, office, etc., are located along the shore in a double row of steel buildings almost parallel with the water line of the lake.

The camp is designed fundamentally to give students practice in surveying, yet they are given opportunity to design simple structures and to help carry out the plans thus made. In this way, a good harbor has been provided. A cistern for containing water pumped from the well has been built and a pipe line extends therefrom to the main street of the camp, thus bringing the well water practically to each tent. A 4 h.-p. kerosene engine furnishes power for pumping water and running a generator for lighting the camp. Two concrete storehouses have been built and a concrete platform for adjusting instruments has been laid. A complete sewer system with septic tank was installed in 1915.

An instrument building, fourteen feet by twenty-eight feet, was built in 1917 and affords excellent facilities for the storage, care and issuing of instruments. A concrete sidewalk was laid along the north side of the main street of the camp in 1918 and the street transformed into a stretch of model gravel road.

The director of Camp Davis extends a cordial invitation to all members of the Society for the Promotion of Engineering Education who are interested in surveying camps, or the teaching of surveying generally, to visit Camp Davis after the session at Ann Arbor. A train leaves Detroit on the Michigan Central Railway each evening at nine. This reaches Cheboygan the following morning at about seven. The camp will make arrangements to meet delegates at Cheboygan if notice is given in advance. By telegraphing Professor C. T. Johnston, Topinabee, Michigan, Camp Davis, the message will be telephoned to headquarters on Douglas Lake.

The Excursion to Detroit.

Although the University of Michigan is situated in a small residential city, it is, fortunately for our meeting, very conveniently located with reference to several of the great manufacturing centers of the country. Detroit, Toledo, Jackson, Flint, Lansing are all within short distances and easily accessible. One day or part of one day will be devoted to a visit to some of the points of interest to engineers in Detroit. While the plans are not yet, of course, very definitely worked out, the list of possibilities is attractive. There are the automobile factories for the mechanical engineers, the power house and substation of the Detroit Edison Company for the electrical engineers, the Waterworks Pumping Station, one of the largest in this country and the sewer system upon which Detroit is spending $1,000,000 a month for the civil engineers, Park, Davis & Co. Frederick Stearns, the great paint and varnish industries and the coke industries will be of interest to the chemical engineers, and the shipyard of the Great Lakes Engineering Works at River Rouge to the marine engineers. The Detroit River Tunnel, the Livingstone Channel, the Michigan Central passenger terminal, one of the most complete classification yards in the United States, and many other features will be attractive as points to visit for those whose interest is more general.

OUR PLACE OF ENTERTAINMENT.

The Michigan Union Building, the new $1,000,000 club house, built by the alumni of the university will be the headquarters of the society during its sojourn in Ann Arbor.

No more ideal place can be imagined for the entertainment of a convention of men like the S. P. E. E. than the Michigan Union. The great club house, which with its furnishings has already cost over a million dollars, offers every possible accommodation furnished by the best Metropolitan hotels with a number of features added that will appeal especially to a crowd of college men. The attractive guest rooms of the club will furnish sleeping accommodations for the visiting delegates, supplemented if need be by the neighboring fraternity houses. The large dining room will make it possible for all to sit down together at meals, which will add greatly to the social enjoyment of the convention. The lobby and concourse are spacious enough to make an ideal lounging and meeting place for our delegates, and there are eleven private dining rooms and numerous committee rooms for meetings of small groups for convention business. The assembly room, which seats 600, and the small lecture rooms will also be found to be well adapted to the needs of our convention. During our stay, all the facilities of the club house will be available to guests, the library, barber shop, billiard room and bowling alleys, and the swimming pool which can accommodate 200 swimmers at one time. Directions will be given in a later number of the BULLETIN as to how to make reservation of accommodations at the Union.

The engineering college of the University of Michigan is most enthusiastic over the prospect of welcoming the members of the S. P. E. E. to Ann Arbor. We hope a great many will come and that they may feel that their coming was both profitable and pleasant.

THE CLASSICS FOR ENGINEERS.

BY EVAN T. SAGE,

Professor of Latin, University of Pittsburgh.

In recent years there has been a vigorous discussion of the value of the classics as preparation for various professions, and such men among engineers as Dean Cooley, President Drinker, Professor Chatburn, Mr. Steinmetz and Professor Vedder have urged that the classics may contribute something to the training of the engineer. Mr. Rudolph Hering, however, has taken the opposite position in an article published in the *Engineering News-Record* for June 26, 1919, and this paper called into existence the present discussion. I shall not do more than answer some of Mr. Hering's arguments, leaving to others the task of presenting in greater detail the positive argument for the classics.

Mr. Hering's title is "Training in Latin and Greek Not Best for Engineers." If he means by this that there are other forms of training that are better for engineers than the classics, we shall all no doubt agree with him. Certainly no classicist nowadays would argue that everyone should study the classics, or that the classics should form the universal and inevitable element in education of every type. But if he means that it is not best that engineers should study the classics at all, then I shall dissent.

Mr. Hering believes that the thing of prime and universal importance is the knowledge of one's mother tongue, and admits that Latin and Greek might be taught in a manner to contribute very much to the engineer's knowledge of English. The student could learn from such a course the meaning of many Latin and Greek roots that are still productive, as well as the meaning of many phrases and words that have been taken over bodily into English. Mr. Hering will be glad to know that every first year book in Latin published in the last five years is based on the belief that the first and most immediate profit to be gained from the study of Latin is the increased mastery of English, and that the last beginning book in Greek is written for the sole purpose of acquainting the student with some of the Greek roots that are used by scientists today, and that the book can not be used as an ordinary beginning book in Greek at all. The teaching of Latin, particularly, is being revolutionized in this country by the growing recognition of the value of the ancient language in understanding the modern. More than half—some authorities say as high as 80 per cent.—of the ordinary English vocabulary is of Latin origin, while the technical terms that are being added every day are overwhelmingly Latin and Greek. Think of the new words that the war brought into everyday use—words like aeroplane, submarine, terrain, mandatory, personnel—practically all of Greek or Latin origin. Think too of the manufacture of compounds. The old Anglo-Saxon prefixes and suffixes are dead; the Latin, alive. In this respect it is, as someone has said, the English that is the dead language, not the Latin. Latin lives, if in no other way, as the productive part of the English speech.

Mr. Hering's method of teaching the classics, then, has many supporters among teachers of the classics, and his objection to Latin and Greek in large measure disappears. He will be glad to know of the increasing number of courses all over the country where the value of Latin for English is emphasized. The Carnegie Foundation recommends a special course in Latin for the teacher in the seventh and eighth grades and the high school English teacher. The Dorchester High School of Boston some years ago introduced Latin into its commercial course, and the precedent has been followed in Cincinnati, in the evening schools of Pittsburgh and elsewhere, with great success. A class of students in Maine, unable to progress in the ordinary way in Latin, last year made remarkable advancement in studying Latin for the sake of English. Many educators believe that this is to be the prevailing method of studying Latin in the future. But we have found out that 90 per cent. of the words in the Cæsar and Cicero read in the high school are productive of English derivatives, in numbers ranging from one up to more than six hundred in the case of one word at least. This shows that to make even a little Latin useful in this way we do not need a special course or special vocabularies, but only a different method, and it is to be feared that the adoption of a special course like that described by Mr. Hering will not prevent the occurrence of such grammatical blunders as *this phenomena* and *seperate,* to use Mr. Hering's examples. This result will more certainly be gained by the older method, modified somewhat to put more emphasis on the study of English derivatives. Many experiments have been tried in teaching derivatives by working backward from English rather than forward from Latin, but all have proved tedious and unsatisfactory, and this method misses the other good results that follow from the study of the classics direct.

So progressive Latin teachers are doing every day—not in quite Mr. Hering's way, it is true—precisely what Mr. Hering wants them to do, and his argument answers itself.

According to Mr. Hering, one of our "pet reasons" for urging the retention of Latin and Greek is to get the ability to read these languages easily in the original. This, he says, we fail to accomplish. But I know of no teacher of Latin who would suggest that the sole reason for holding on to the classics is that his students are able to read them easily. It is true that few can read Latin easily after completing a high school or even a college course, but that is not the aim of any teacher of my acquaintance, and I for one believe that if we cared to make that our purpose we could accomplish it. We prefer other goals. This does not mean that I agree with Mr. Hering that all the ancient literature worth considering is available in modern translation. No one who has ever really translated a literary work will seriously claim that his translation can or does have the same qualities as the original. Ancient literature is not available in translation, and never can be. Such works as those of Vitruvius on architecture or Frontinus on aqueducts, which convey information, may be translated with reasonable success, but no translation has ever produced the effect of a tragedy of Æschylus or an oration of Cicero.

Another "pet reason" according to Mr. Hering for the study of the classics is to get mental discipline. Probably there has been more criticism of the classics on the ground of their claim to train the mind than on any other. For years we have been told that there is no such thing as mental discipline or training. Mr. Hering, however, finds fault with us, not because our claim is unjustified, but because the discipline we impart is inferior to that of science, as grammatical laws suffer exceptions while natural laws do not. The subject of formal discipline is still in the stage of debate, and until experimental psychology gives us more certain knowledge than we now have, comparisons of the quality of various kinds of discipline are dangerous. This much may be said, that certain objects have primarily content value, others interest value, and still others procedure or method value, and that few if any other subjects combine these three forms of value to the same degree as the ancient languages. We may question too whether this discipline of science is constantly in the minds of teachers of biology or chemistry as it is in the minds of teachers of Latin or Greek. Unless it is a constant and definite aim it may be doubted whether the disciplinary value of science as often taught is superior to that of the classics as usually taught.

Finally, Mr. Hering gives to students of engineering and allied professions the credit for practically everything that has been done to advance modern civilization. Recent progress, he says, is due to professions that have not been based on Latin and Greek rather than on those that are so based. But medicine and law, architecture and sculpture, have progressed without the help of the classics. Such a statement is rash. Modern architecture is based entirely on that of Rome. The arch, the dome and the vault were used if not invented by Roman builders, and the work of Roman architects has been the means of instruction of every succeeding generation.

Furthermore, it should be remembered that the scientific spirit, which brought to pass all the triumphs of modern sanitation, agriculture, and other professions, is not the child but the parent of modern science, whether pure or applied, and I should want to hear the claims of pure science before I conceded the claims of applied science to the credit for progress. The scientific spirit had its origin in the necessity felt by the scholars of the Renaissance to interpret classical texts. The Renaissance itself was in origin nothing but a revival of interest in the classics. From this came increased interest in the facts of the universe and better information on astronomy and geography than the middle ages could supply. Intellectual curiosity was another product of the Revival of Learning, and it in turn had such different consequence as the discovery of America and the Protestant Reformation.

There is a fundamental though unexpressed idea which determines Mr. Hering's point of view, that the engineer is a being set apart from the beginning, and clearly differentiated from ordinary human beings. If this could be granted, it would naturally follow that the training of the engineer would be from the cradle such as to make of him a perfect engineer, no matter what else were excluded. Granting that the classics as often taught at present, though not as they may be taught, give to the engineer little that he can put to immediate use, we believe that the study of the classics by any method may contribute a great deal to the engineer who may occasionally participate in human relations that are not in the narrow sense those of the engineer. Simply because a man is an engineer is no reason why he should be excluded from the privilege of studying the classics. I for one do not favor a universal requirement of Greek or Latin, but I am not able to tell in advance what persons will profit by their study and what persons will not. I know of no reason why the engineer as such should not profit thus. Our faith in the value of the classics as a means of education is based on the fact that there is perhaps no other subject that will serve the student in so many different ways. The peculiar advantage of the classics lies in their combination of values. A study of etymology from the English standpoint may increase one's knowledge of English, but will scarcely increase one's appreciation of the continuity of history. Mathematics may be superior as a discipline, but as usually taught will not contribute much to one's esthetic development. The study of strength of materials may furnish one with valuable facts and methods, but usually will not lead to a profounder consciousness of one's civic and national obligations. But the study of the classics may do all these things, and more. Better control of the English language, a sense of the continuity of history and the evolution of society, valuable training (even if not the most valuable), esthetic appreciation, useful knowledge, and local and national pride, may all be products of the study of the classics. Few will gain all these things, but still fewer will miss all of them. But in addition, for the student of law, medicine, pharmacy and theology, Latin, and to a less degree Greek are vocational subjects. For every one who is called on to use the English language with force, accuracy, clearness and propriety, Latin is almost a necessity. President Hollis has recently found in Periclean Athens the origin of art, literature, philosophy and even science. No one who reads Cicero or Pliny can fail to be impressed by the multitude of resemblances between our own society and that of ancient Rome. Practically every political and economic problem that we face confronted the ancients, and in their experience we have an invaluable resource. Even the character of Wilhelm of Prussia seems familiar to readers of Cæsar.

Granting that ancient achievements in the fields of astronomy, agriculture, geography, surveying, mathematics and architecture have been so completely absorbed in modern doctrine as to be unrecognizable, shall we still deny to the engineer his right to the rich heritage of the past? The student who takes such a brief course as that Mr. Hering recommends to us would gain much in his ability to differentiate between apparent synonyms and in his appreciation of the real meanings of English words, but he would also miss much. Shall we deny to him the opportunity to make himself master of grammar, to smooth his path toward the acquisition of French and Spanish, to widen his mental horizon by contact with other forms of expression than hand-books and contracts? Shall we deny to him, because he is an engineer, the opportunity to become even imperfectly acquainted with two great literatures and two great civilizations? Modern civilization is the result of the fusion of Hebrew religion, Greek philosophy and democratic instincts, Roman law and instinct for order and discipline, as these things were appropriated by the vigorous peoples of northern Europe. To two of these three elements in modern civilization only the student of the classics holds the key. No master key exists. No other means of entrance can be found. To change the figure, no substitute has ever been devised for Latin and Greek as a means of understanding the Greek and Roman civilizations, and there is no way of understanding our own without understanding them. No historian can teach ancient history without knowing the classics; no one can interpret modern literature without knowing the ancient. I see no reason for depriving the engineer of this opportunity. He must play his part on the stage of modern life; let him be as well equipped as he can be. All the things the study of the classics can bring him should be his. Antiquity is part of his inheritance. Rome the Eternal City is the symbol of something imperishable—something that is a solid and substantial foundation for modern civilization.

EDITORIAL.

The Secretary read the interesting description in regard to the University of Michigan published in this number of ENGINEERING EDUCATION, and especially that part which deals with the entertainment of the members of this Society at the next annual meeting. This was so interesting and fascinating that it seemed one of the pleasantest things that could happen would be to attend this meeting. To quote from the article by Professor Nelson:

"No more ideal place can be imagined for the entertainment of a convention of men like the S. P. E. E. than the Michigan Union. The great club house, which with its furnishings has already cost over a million dollars, offers every possible accommodation furnished by the best Metropolitan hotels with a number of features added that will appeal especially to a crowd of college men. The attractive guest rooms of the club will furnish sleeping accommodations for the visiting delegates, supplemented if need be by the neighboring fraternity houses. The large dining room will make it possible for all to sit down together at meals, which will add greatly to the social enjoyment of the convention. The lobby and concourse are spacious enough to make an ideal lounging and meeting place for our delegates, and there are eleven private dining rooms and numerous committee rooms for meetings of small groups for convention business. The assembly room, which seats 600, and the small lecture rooms will also be found to be well adapted to the needs of our convention. During our stay, all the facilities of the club house will be available to guests, the library, barber shop, billiard room and bowling alleys, and the swimming pool which can accommodate 200 swimmers at one time."

Further proof of the pleasantness with which meetings of the Society is associated is given by Dean Butler, who recently wrote to this office as follows:

"Most of us regard attendance at these meetings in the light of a very enjoyable vacation."

INFORMATION DESIRED.

The Secretary desires the correct address of the following members:

Adamson, K. F.
Bevan, W. A.
Chedsey, W. R.
Cross, Hardy
Dalburg, F. A.
Dickinson, L. P.
Doland, J. J.
Dreyer, C. F.
Ely, John A.
Ford, H. C.
Hamlin, H. L.
Harvey, J. W.
Holmes, P. E.
Johnson, W. F.
Kamrass, Benjamin
Lewis, F. J.
Linville, C. P.
Mark, R. M.
Mavity, V. T.
Merrill, J. L.
Miller, Hugh
Ockerblad, A. M.
Robertson, J. E.
Rusk, W. W.
Shutt, J. C.
Stivers, E. R.
Sturges, F. L.
Storm, E. R.
Tanzer, E. Dean
Veal, C. B.
Wing, S. R.
Wolfe, W. S.

TREASURER'S REPORT.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION,

June 21, 1919.

Trading Account.

June 21, 1918 Inventory	$2,675.70	
Cost of Publications	3,558.54	
	$6234.24	
Less inventory	2,546.00	
Cost of sales		$3688.24
Sale of publications to members and non-members.	$ 177.51	

One-fourth of members' dues	1,317.50	
Three-tenths of institutional dues	203.25	$1,698.26
Advertising	$ 972.50	
Less discount	13.19	959.31
		$2,657.57
Balance—Profit and Loss Account. *Loss*		1,030.67
		$3,688.24

PROFIT AND LOSS ACCOUNT.

Balance, trading account		$1,030.67
Annual meeting, 1918	$ 426.89	
Committee expenses	114.60	
Treasurer's office	331.36	
Secretary's office	1,000.00	
Secretary's clerical assistant	1,190.00	
Postage and express	302.90	
Telephone and telegraph	54.09	
Office sundries	61.02	3,480.86
		$4,511.53
Dues—individual	$3,952.50	
Dues—institutional	474.25	
Exchange	1.55	
Interest on deposits	16.69	$4,444.99
Balance—loss for year		66.54
		$4,511.53

BALANCE SHEET.

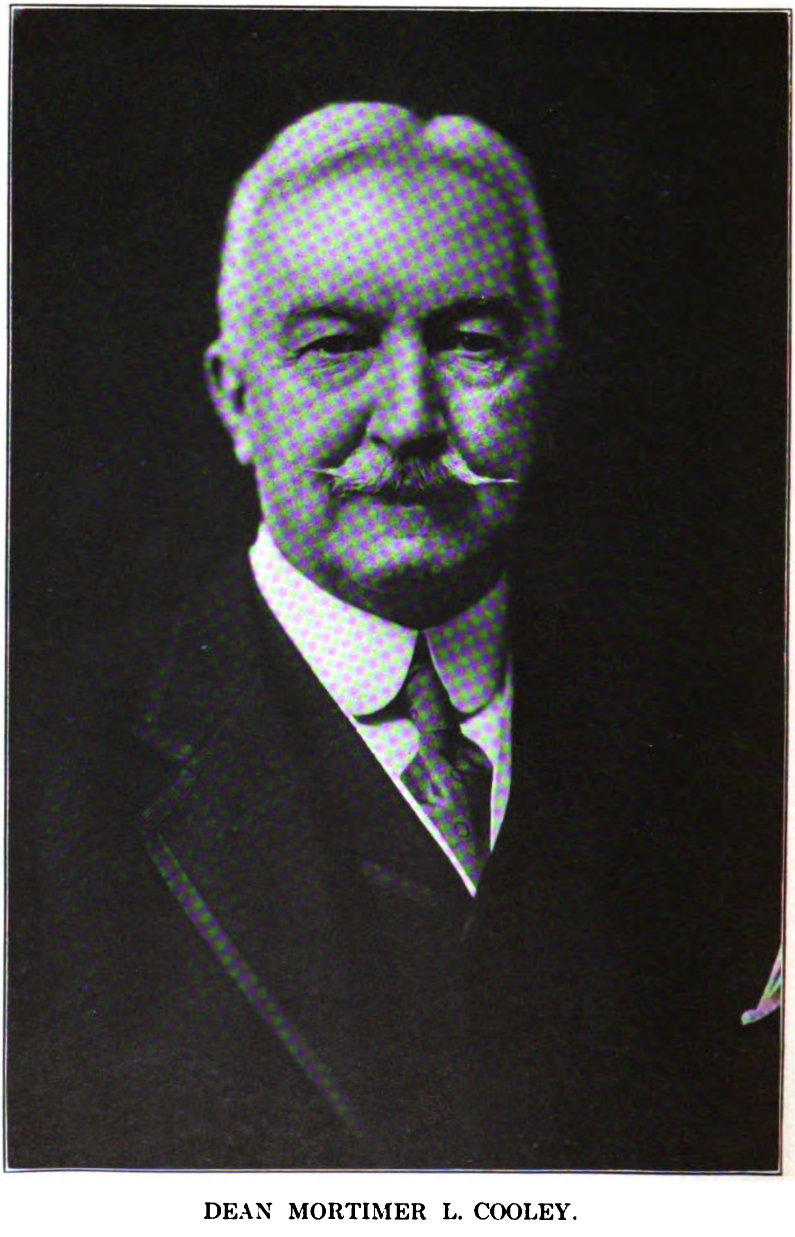
Assets.

Accounts Receivable:		
Individual—		
Current dues	$1,577.50	
Back dues	2,758.72	
Institutional—		
Current dues	141.00	
Back dues	92.50	
Members and non-members	263.62	
At Dr. Bishop's office	38.94	$4,872.28
Cash:		
Lincoln Trust Co.	621.45	
Life Membership Fund	447.26	
Dr. Bishop's office	150.00	1,218.71
Inventory		2,546.00
		$8,636.99

TREASURER'S REPORT.

Liabilities and Surplus.

Accounts payable:		
Members paid in advance	$ 154.42	
Dr. Bishop	373.05	
The New Era Printing Co.	3,392.11	3,919.58
Surplus	$4,336.69	
Less—loss for year	66.54	4,270.15
Life memership		447.26
		$8,636.99



DEAN MORTIMER L. COOLEY.

BULLETIN

OF THE

Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee:

Arthur M. Greene, Jr., John F. Hayford, F. L. Bishop, *Editor*.

Address all communications to the Editor, University of Pittsburgh, Pittsburgh, Pa.

VOL. X LANCASTER, PA., MAY, 1920 No. 9

TABLE OF CONTENTS.

Mortimer E. Cooley 375
The Hyphen in Engineering Literature. F. Sturges Allen........ 379
A General Engineering Course. C. H. Benjamin................ 392
Georgia Tech Section. R. R. Kirk............................ 397
Methods of Preparing Reports for Tests in Engineering Laboratories. H. H Fikrer.................................... 399
Preliminary Report of the Committee No. 11-A, Physics.......... 406
Preliminary Report of Committee No. 12, English.............. 410
Committee No. 22, Intelligence Tests......................... 417
Editorial 423

MORTIMER E. COOLEY.*

Mortimer E. Cooley was born March 28, 1855, at Canandaigua Township, Ontario County, New York. He spent three terms in the old Canandaigua Academy. He boarded himself two winter terms and walked from his home, three and one half miles away, one spring term, "doing the chores" morning and evening. That and taking care of the garden Saturdays were the conditions which secured for him the unusual privilege of being excused from regular farm work. For two winters he taught district school and in that way earned the money needed to pay his expenses at the Academy and to finance his next step towards an education.

---

* *Michigan Technic*, December, 1919.

The four-year course for cadet engineers was established in 1874 at the U. S. Naval Academy and appointments were open to competition. Of some seventy candidates who tried the examination, twenty-five were appointed; Mortimer Cooley passed seventh and four years later graduated seventh in a class of fourteen. He took an active part in athletics, was captain of his class crew, and stood high with the foil and broadswords.

On graduating from the Naval Academy, he was assigned to the U. S. S. *Quinnebaug,* which sailed in the fall of 1878 to the Mediterranean. He returned on the U. S. S. *Alliance* a year later and on Christmas day, 1879, was married to Carolyn Elizabeth Moseley, of Fairport, New York.

Cadet Engineer Cooley was assigned to the Bureau of Steam Engineering at the Navy Department. In June, 1881, he was examined and promoted to assistant engineer and in August was ordered to the University of Michigan to teach steam engineering and iron shipbuilding. At the end of three years, on request of the regents, his detail was continued a fourth year. Being then detached and ordered to the Pacific Station, the regents conferred on Assistant Engineer Cooley the honorary degree of Mechanical Engineer and invited him to resign and accept the chair in mechanical engineering. This he did, his resignation taking effect December 31, 1885. It was with a great deal of regret that he resigned, as he was in love with the Service. There was at the time no prospect for any great increase in the naval force, and it seemed to him the opportunity for real work afforded him at the university ought not to be declined.

He has been dean for fifteen years, having been appointed in February, 1904. The Michigan Agricultural College conferred on him the degree of LL.D. in 1907, and the University of Nebraska the degree of Eng.D. in 1911. When he came to the university there were but sixty or seventy engineering students out of a total of about thirteen hundred in the university, and the entire technical work in engineering was done in seven rooms at the south end of the main university building. The first engineering laboratory was built the winter after he came. It was a two-story brick veneer building 24x36 feet, costing $1,500 and the equipment $1,000. In it Professor Cooley himself taught forging, pattern-making and machine-shop practice. It was styled by his colleagues "the Scientific Blacksmith Shop." It was the beginning of an effort, now altogether general, to give to engineering students, while in college, some practical knowledge of the materials and processes used in the execution of engineering projects.

Dean Cooley was from 1895 to 1911 the chief engineer officer of the Michigan State Naval Brigade and is now a retired officer in the Brigade.

Following his return to the University after ten months' service in the Spanish-American war, Professor Cooley was invited by the Citizens' Committee of Detroit, of which Governor Pingree was chairman, to appraise the power plants, rolling stock and stores and supplies of the Detroit street railways, which the city was contemplating purchasing. It was a hurry job and was done in a hurry. The appointment was made on Friday, the staff organized Saturday and the report submitted the following Saturday, covering $2,000,000 of property. The following year, 1900, at the request of Governor Pingree, the Board of State Tax Commissioners, and the Board of State Auditors, Professor Cooley undertook to appraise the specific tax paying properties of the State of Michigan, which included the Steam Railroads, the Telegraphs, the Telephones, the Plank Roads and the River Improvements.

Michigan's pioneer work in valuation of large public utility properties was soon followed by other states. First among them was Wisconsin in a valuation of her steam railroads. Substantially the same methods were employed as in Michigan. Professor Cooley was consulting engineer.

Nor has Professor Cooley neglected opportunities to serve in other capacities. He was for a time chairman of the Board of Fire Commissioners, and president of the Common Council in AnnArbor in 1890–91. He served on the Board of Awards for the World's Fair in Chicago in 1893, and for the Pan-American Exposition in Buffalo. He has for twenty-five years served as mechanical expert in patent cases, and testified many times on mechanical matters before juries and commissions. He was for five years (1907–1912) chairman of the Block Signal and Train Control Board of the Interstate Commerce Commission.

Professor Cooley is a Fellow of the American Association for the Advancement of Science, member of the American Society of Mechanical Engineers, American Society of Civil Engineers, American Institute of Consulting Engineers, Franklin Institute, Society for the Promotion of Engineering Education, Society of Naval Engineers, Michigan Engineering Society, Detroit Engineering Society, Sigma Phi, Tau Beta Pi, Sigma Xi, the Army and Navy Clubs in Washington and in New York, the Detroit Club and Yondotega Club in Detroit.

THE HYPHEN IN ENGINEERING LITERATURE.*

BY F. STURGES ALLEN,

General Editor, Webster's New International Directory.

The purpose of this paper is to examine the development of the use of the hyphen in engineering literature.

To this end I have restricted my special researches to engineering literature. Yet it is obvious that engineering topics are so diversified in their nature and so wide in their scope that engineering literature cannot be—neither would it desire to be—divorced either from the literature of the physical sciences in general or from pure literature itself. In its hyphen characteristics it closely resembles the literature of the physical sciences in general, of the industries and the trades, of the newspapers, and of much other miscellaneous writing,—using rather more two-noun combinations than some of the sciences, about the same as the American newspapers, and fewer than much of the literature of trade and industry.

The uses of the hyphen in forming compound or derivative words may be broadly divided into three classes: I. The use in forming derivatives from words by adding to them a prefix or suffix, as *ante-*, *anti-*, *be-*, *dis-*, *hyper-*, *in-*, *non-*, *semi-*, *sub-*, *super-*, *supra-*, *ultra-*, *un-*, etc. There is no material difference of opinion as to the principle regarding the use of the hyphen in such words, and in many cases whether the hyphen is used or not is not a matter of animadversion or comment.

II. The use which has been called "grammatical," where the hyphen serves to connect two or more words used together as a part of speech to govern or limit a following word or group of words, as in *road-mending* operations, an *out-and-out* opponent, a *two-horse* wagon, an *ill-built* house, to *short-circuit* a battery.

---

* This paper provided by Committee No. 20, Standardization of Technical Nomenclature.

This use of the hyphen is comparatively recent, and has been fairly uniform from the beginning: whether it is observed or not in any particular instance, it is generally agreed that in such combinations the hyphen should be used. The fact that the rule is not always followed, even on the same page, I interpret as being due rather to the incapacity of the mind always to observe even the less subtle distinctions than to the existence of any question as to what is the proper form of the combination.

III. The use in forming compound nouns by the combination of noun with noun or of adjective with noun, as *airplane, beehive, blackbird, blackguard, steamship, windmill, lifeboat* or *life-boat, footboard* or *foot-board, motorman* or *motor-man, crank pin, crank-pin,* or *crankpin, goldenrod, horse power, horse-power,* or *horsepower, connecting rod* or *connecting-rod, cantilever bridge, gravity cell* or *gravity-cell, storage battery* or *storage-battery.*

This list of course could be extended indefinitely; I have chosen here merely a few typical examples. Whether or not to use the hyphen in words of this class is the main question concerning the use of the hyphen about which there is any difference of opinion among modern writers and printers. The number of compound nouns formed by the union of adjective (other than the participle) and noun is so small and their form generally so well fixed by a compelling usage that they may here be left out of account.

Prior to about 1850 engineering literature, as well as the literature devoted to the other physical sciences and the industries (with which engineering literature must be classed), was little more than a part of the general literature of the language, and there was among most of its authors a conscious effort to conform its diction to that of pure literature. There had then arisen no great body of technical literature with, more or less, a method and press of its own. The number of noun combinations made by juxta position of the noun with noun or of participle or gerund in *-ing* with noun was small as compared with those to be found in our present literature of that kind.

Therefore this class of words had received but little attention, and their place in the language was not clearly understood: hence, we see them confused with such ordinary adjective noun combinations as *Christian name,* which is mentioned as a compound by the early grammarians, as Lindley Murray and Goold Brown. In the early dictionaries, including *Webster's Dictionary* as late as the edition of 1864 and *Worcester's Dictionary* down to the last edition, we find hyphened such compounds as *bitter-apple, bitter-cucumber, black-iron, Black-Monday, black-martin, black-vomit,* the adjective phrases being uniformly given as hyphened compounds in the vocabulary.

The very modern notion of some that nouns cannot be used adjectively, however, seems not to have entered the heads of these early writers, for both Murray and Brown, with various others, say explicitly that the noun can be used adjectively, and confirmation of this is not wanting in the works of our best modern philologists and grammarians. Thus, to mention but one instance, John Earl, in his "Philology of the English Language," says (p. 420): "Thus, *brick* and *stone* are substantives; but mere position before another substantive turns them into adjectives, as *brick house, stone wall;* and the latter when condensed into a compound substantive, *stone-wall,* may again by collocation make a new adjective, as 'Stone-wall Jackson.' Thus we speak of *garden flowers* and *hedge flowers:*

> 'Near yonder copse, where once the garden smiled,
> And still where many a garden flower grows wild.'
> Oliver Goldsmith.

In some instances a substantive, through long standing in such a position, has acquired the adjectival habit exclusively, as *milch,* in the expressions 'milch cow,' 'milch goat.'"

But whether we call the limiting noun an "adjective" or not does not affect the question as to whether the noun is used as a qualifying or attributive word before another noun without a hyphen between the two.

For the purposes of this paper I examined with care more than twenty of the standard books published about 1850 on the sciences and arts. The results can here only be briefly stated. I found them to consist rather definitely of two groups: (1) those which use the noun freely (for those days) to limit another noun, using very few hyphens; (2) those, a smaller group, which make fewer combinations of noun with noun, and use hyphens in very many of them.

The extreme system of hyphenating even adjective compounds has now been completely abandoned in the dictionaries. But the use of the hyphen to join nearly every two-noun combination and many combinations of noun with *-ing* forms (participles or gerunds) has been retained to the present day in one (the *Standard Dictionary* of Funk & Wagnalls) of the two chief current one-volume dictionaries. *Webster's Dictionary* broke away from the system in the edition of 1890, called *Webster's International Dictionary,* and has never gone back to it. In the analysis made later I shall designate the first work as "F" and the second as "W."

For the purpose of having for this paper some definite information as to what present engineering use is, I have examined seventeen different works* on subjects connected with the science of engineering, and have listed all the noun combinations occurring on pages taken entirely at random, noting those of noun with noun and of *-ing* forms with nouns where the form might be in question.

---

* The books examined were chosen as they were run across in order to give a fair selection. They are, briefly designated: Audel, *Pumps and Hydraulics* (1905); Bedell, *The Transformer* (1896); Crocker, *Electric Lighting* (1906); *Elec. Railway Journal,* July, 1919; *Engin. and Mining Journal,* July, 1919; *Engin.-News Record,* July, 1919; *Everyday Engin. Mag.,* July, 1919; Fleming, *Elec. Wave Teleg.* (1906); Gerhard, *Water Supply, Sewerage, and Plumbing* (1909); *The Iron Age* (1918); Peake, *Hydraulics* (1906); Rogers *Pumps and Hydraulics* (1905); Tonge, *Coal Mining* (1906); Waddell, *Bridge Engineering* (1916); Wilson, *Hydraulic and Placer Mining* (1903); and *Mine Ventilation* (1900); Young, *Complete Motorist* (1904).

About the same number of combinations were listed from each book, making a total of 1024 combinations, with 80 more in which the first element was of a kind that usage now rather uniformly treats as an adjective, as *average, bottom, top,* and *brass, iron, steel, lead, aluminum, mercury,* or other name of a substance used with the sense of "made of," as in *average loss, bottom member, steel web, aluminum casting.*

Of the 1024 combinations (representing just that class of combinations hyphened in F and usually given as two words in W) 55 were solid words in form, 135 hyphened words, and 834 two words. All of the 80 combinations with *average, bottom, brass,* etc., were two words.

TABLE I.

39 SOLID-WORD COMBINATIONS OF MONOSYLLABLES.

Words as in List.	As in F.	As in W.	Words as in List.	As in F.	As in W.
airplane		⁐	lifeboat	-	⁐
airway	⁐	⁐	lightship	-	⁐
beehive	⁐	⁐	limestone	⁐	⁐
crankcase		# or ⁐	manhole	⁐	⁐
crankshaft	-	# or ⁐	mouthpiece	⁐	⁐
dashboard	⁐	⁐	network	⁐	⁐
dovetail	⁐	⁐	notebook	-	⁐
fireman	⁐	⁐	railroad	⁐	⁐
flagman	⁐	⁐	railway	⁐	⁐
flagpole	⁐	⁐	roadway	⁐	⁐
flywheel	⁐	⁐	snowshoe	⁐	⁐
footboard	-	⁐	steamship	⁐	⁐
footstep	-	⁐	stovepipe	⁐	⁐
gearbox	-	⁐	trainman	⁐	⁐
gooseneck	⁐	⁐	viewpoint	-	⁐
handwheel		⁐	washpan	-	
hedgehog	⁐	⁐	wayside	⁐	⁐
horseshoe	⁐	⁐	windmill	⁐	⁐
keyboard	⁐	⁐	workman	⁐	⁐
keyway	⁐	⁐			

I compared all the listed combinations with the two dictionaries which typify the one (F) the usage favoring the hyphen, the other (W) the usage favoring its omission. It would be interesting as well as profitable to give the lists in full; but space forbids. I will, therefore, give only those combinations found in one or the other of the dictionaries, and these combinations are typical of the entire list. I have grouped together (1) the combinations of monosyllables, (2) the combinations of dissyllables with monosyllables or dissyllables, and (3) the combinations in which one element is a trissyllable. In the columns the symbol [#] means that the combination is given as two words (unhyphened) in the dictionary under which the symbol occurs, [-] that it is hyphened, and [⁐] that it is a solid word (with the elements joined and no hyphen). The words in the columns appear as noted in the list.

This table of 39 solid words shows no great difference in treatment between the two dictionaries. Only two of the 41 solid words in the complete list were not to be found in either of the dictionaries; these two words are *bridgework* and *kneeslide*. It is plain, therefore, that the solid-word form is sparingly used for combinations and only where the feel for it is strong and very general. The chief characteristic of the combinations seems to be that the individuality in sense of the thought elements is pretty much lost in the word as the name of a simple thing. This we see more perfectly exemplified in such terms as *breakfast, shipshape, whitewash;* in *daisy, woman, manly,* etc., the elements are etymologically so obscured that they can be discovered only by historical methods.

This table of 40 hyphened combinations of monosyllables shows at once a decided difference in treatment by the two dictionaries, the one giving most of them as hyphened, the other the majority in the two-word form. The variations to the solid-word form [⁐] evidently were made in an effort to conform to usage. In the list as a whole the thought elements involved in the combinations are felt individually by the mind more than they are in case of the words in the first list.

Of the hyphened-word combinations of monosyllables in the complete list, 24 are not in either dictionary. A few of these are: *air-vein, arch-bridge, bridge-steel, coal-dust, coal-seam, fan-drift, field-core, guide-crown, tail-sluice.* The number (64) of hyphened combinations in and not in the dictionaries shows that the hyphened-word form is more freely used than the solid-word form.

TABLE II.

40 Hyphened-word Combinations of Monosyllables.

Words as in List.	As in F.	As in W.	Words as in List.	As in F.	As in W.
air-box	-	#	head-frame		⁐
air-gap	-	#	head-race	⁐	⁐
air-valve	-	#	hill-side	⁐	⁐
bed-plate	-	⁐	marsh-gas	-	#
bed-rock	-	⁐	pin-hole	⁐	⁐
cap-piece	-		pipe-line	-	#
car-mile	-	#	sand-bar	-	
coal-gas	-	#	sand-box	-	
cog-wheel	-	⁐	side-plate	-	
crank-pin	-	# or ⁐	slide-rule	-	#
drive-pipe		⁐	sluice-box	-	
eye-bar	-	⁐	snow-line	-	#
fire-damp	-	#	stand-pipe	-	⁐
fly-wheel	-	⁐	sway-brace	-	⁐
force-pump	-	#	tail-race	-	⁐
gas-pipe	-	# or ⁐	ton-mile	-	#
guide-blade		#	tram-car	-	⁐
guide-ring	-		waste-gate	-	#
hand-hole	-	⁐	wheel-base	-	#
hand-wheel		⁐	wheel-work	⁐	⁐

This table too shows a striking difference between the dictionaries, F hyphening nearly all the combinations, W having nearly all in the two-word form.

It is noticeable that this table includes a considerably larger number than either of the two preceding tables; but a still more significant fact is that besides the 55 combinations in the dictionaries the complete list includes 102 combinations not in either, making 157 such combinations in all. A few of those not in F and not in W are: *air plane* (= plane of air, not aeroplane), *arc type, arch bridge, ball float, bank sand, belt drive, spark gap.* Comparing the complete lists of the three forms (⁐, -, #), we find 157 #, 64 -, and 41 ⁐, showing that the two-word (#) form is the one most freely used, there being nearly three times as many # (157) as there are hyphened (64). From this we can see that there is a strong tendency (at least in engineering works) to use the two-word form. Why the hyphen is used in the words in the previous list and not in those in this must be due merely to the personal idiosyncrasies of the users; no other reason is to be discovered.

TABLE III.

55 COMBINATIONS OF MONOSYLLABLES, IN THE TWO-WORD FORM.

Words as in List.	As in F.	As in W.	Words as in List.	As in F.	As in W.
air gap	-	#	road work	-	
air pump	-	#	rock shaft	⁐	⁐
air tap	-		screw cap	-	
arc lamp	-	#	screw joint	-	
ball race	-		sheet iron	-	
ball valve	#	#	slide rule	-	#
brake shoe	-	#	slide valve	-	#
breast wheel	-	#	slip ring	-	#
crank shaft	-	# or ⁐	sluice gate	-	#
drain pipe	-	⁐	soil pipe	-	#
drift wood	⁐	⁐	spark ball	-	
drill press	-	#	spark gap	-	#
force pump	-	#	steam chest	-	#
gas shield	-	#	steam pipe	-	#
gas works	-	#	steam pump	-	#
guide blade		#	steam trap	-	#
guide rope	-	#	steam mill	-	#
hand drill		#	sway brace	-	#
head gate	-	#	tail stock	-	⁐
lathe work	-	#	test tube	-	#
lock nut	-	#	valve gear	-	#
lift bridge		#	valve rod		#
oil hole	-	#	valve seat	-	
pin hole	⁐	⁐	vent plug	-	
pipe line	#	#	waste pipe	-	#
pole piece	-	#	wheel base	-	#
pump rod	-	#	worm gear	-	#
rain water	-	#			

Of the two-word forms, *air gap, arch bridge, bridge steel, coal dust, force pump, guide blade, guide crown, pin hold, pipe line, slide rule, sway brace, wheel base,* also occur as hyphened in the lists,—leaving 145 that occur only in the two-word form. *Crank shaft* alone occurs also as a solid word.

Of the hyphened forms only *fly-wheel* and *hand-wheel* occur as solid words.

TABLE IV.

14 Solid-word Combinations of a Dissyllable with a Monosyllable or a Dissyllable.

Words as in List.	As in F.	As in W.	Words as in List.	As in F.	As in W.
gunmetal..........	-	#	piledriver............	-	#
gunpowder.........	⁐	⁐	policeman............	⁐	⁐
horsepower........	-	# or ⁐	stockholder..........	⁐	⁐
motorman.........	-	⁐	tidewater............	-	⁐
ironstone..........	⁐	⁐	typewriter...........	⁐	⁐
orebody...........	-		waterway............	⁐	⁐
passageway........	⁐	⁐	waterworks..........	⁐	⁐

This table includes all the solid-word combinations of this class found. The fact that the list is so small and includes so few words not given as solid in the dictionaries and no word not in the dictionaries shows that the solid-word form is

TABLE V.

35 Hyphened Combinations of a Dissyllable with a Monosyllable or a Dissylable.

Words as in List.	As in F.	As in W.	Words as in List.	As in F.	As in W.
air-chamber.......	-	#	steam-engine.........	-	#
ampere-turn.......	-	#	stuffing-box..........	-	#
contact-maker.....	-	#	time-table...........	-	-
cutter-bar.........	-	#	trundle-wheel........	-	
exhaust-valve......	-	#	water-closet.........	-	-
field-magnet.......	-	#	water-course.........	⁐	⁐
field-winding.......	-	#	water-gage..........	-	#
gas-engine.........	-	#	water-gate..........	-	#
gusset-plate.......	-		water-jacket.........	-	#
heat-engine........	-	#	water-jet...........	-	
horse-power.......	-	# or ⁐	water-line..........	-	#
living-room........	-	#	water-organ..........	-	#
motor-car.........	-	#	water-pipe..........	-	#
piston-rod........	-	#	water-rain..........	-	#
plate-girder........	#	#	water-supply.........		#
power-house.......	-	#	water-wheel..........	-	#
pressure-box.......	-	#	weather-vane........	-	#
side-cutting........	-				

seldom used for combinations of words of more than one syllable, and then only where the feel for its use is strong.

Only the words *horsepower* and *stockholder* occur, in the list, in any other form; the first we find also as two words and hyphened; the latter also as two words. The similarity of treatment in the two dictionaries is noticeable.

In this table the contrast between the two dictionaries is conspicuous. It is also noticeable that there is but one word, *watercourse* given as a solid word in both dictionaries, showing, like Table IV, that there is little tendency for combinations of this class to become stereotyped solid words. Besides the terms shown above there are in the complete list 34 not in either dictionary, making 69 in all.

Besides the 94 unjoined combinations in this table, there are in the complete list 298 combinations not to be found in either dictionary. A few of these latter are: *air inlet, airplane motor, arc discharge,, tappet valve, wage question, outlet valve, oil reserve, ore reserve, binder screw.* No distinct difference can be drawn between them and those in the table above, but one has the general feeling that most of those not in the dictionaries are more obvious in meaning and less imply a conventionally restricted sense than do those that are.

We find that of the two-word forms 14 occur also in the hyphened-word form: *brush holder, contact maker, cutter bar, fan chamber, field magnet, gas engine, horse power, piston rod, rubbing surface, steam engine, water line, water pipe, water supply, water wheel.*

We find two combinations also in the solid-word form: *horse power* and *stock holder.*

Comparing the combinations of the class shown in tables IV, V, and VI, we are impressed by the fact that nearly six times as many (392) are in the two-word form as are hyphened (69), and that 94 of the two-word combinations are in the dictionaries (in F mostly hyphened, in W mostly as two-words), and of the hyphened combinations 34 are in the dictionaries (in F mostly hyphened, in W mostly as two words).

TABLE VI.

94 Combinations of a Dissyllable with a Monosyllable or a Dissyllable.

Words as in List.	As in F.	As in W.	Words as in List.	As in F.	As in W.
air cooling..........	-	#	nickel steel..........	-	#
angle iron..........	-	#	packing ring.........	-	#
ball bearing.........	#	#	parlor car...........	-	#
beehive oven........	#	#	phosphor bronse......	-	#
bevel gear..........	-	#	pillow block.........	-	#
bevel wheel.........	-	#	piston rod...........	-	#
blast furnace........	-	#	power current.........	-	#
brush holder........	-		power factor.........	-	#
buffer block........		#	pressure gage........	-	#
carbon steel........		#	pump barrel.........	-	
carriage spring......	-		punching machine....	-	#
coaster brake.......	-	#	radius vector.........	#	#
contact maker......	-	#	rocker shaft..........	-	#
contour map........		#	rolling mill...........	-	#
copper loss..........	#	#	sea level.............	-	#
cotton press........	-	#	service pipe..........	-	#
country rock........	-	#	spelter solder.........	-	#
cutter bar..........	-	#	spray nossle..........	-	
datum level........	-	#	sprocket wheel	-	#
driving wheel.......	-	#	steam boiler.........	-	#
drop hammer.......	-	#	steam engine.........	-	#
eddy current.......		#	steam fitting.........	-	#
exhaust part.......	-	#	steam turbine........	-	#
exhaust steam......	-		stock holder.........	⁐	⁐
fan chamber........		#	stock market.........	-	
field magnet........	-	#	suction pipe..........	-	#
field winding........	-	#	suction primer.......	-	#
filter bed..........	-	#	suction valve.........	-	#
flange coupling......		#	sumping shot........		#
friction clutch.......	-	#	surface gage.........	-	#
friction roller.......	-	#	swaddling clothes.....	#	#
gas engine..........	-	#	thrust bearing........	-	#
hand lever..........	-		toggle joint..........	-	#
heater coil..........	-		traction engine.......	-	#
horse power........	-	# or ⁐	tumbler gear.........	-	#
impulse turbine.....	#	#	wagon train..........	-	#
inlet valve..........		#	walking beam........	-	#
iron foundry........	-		water hammer.......	-	#
iron loss............	#	#	water level..........	-	#
iron ore............		#	water line...........	-	#
iron works..........			water pipe..........	-	#
lead pencil.........	-	#	water side..........	⁐	⁐
lead sulphate.......		#	water wheel.........	-	#
linseed oil..........	-	#	winter time.........	-	⁐
machine screw......	-	#	working barrel.......	-	#
milling machine.....	-	#	zinc choloride........	#	#
molding sand.......		#	zinc sulphate.........	#	#

From this it is clear that the usage of the seventeen books examined very decidedly favors the two-word form, and I think those books are typical of general engineering usage.

There is not room here to make any analysis in order to discover some principle of distinction between the two forms. I have, however, made an elaborate but fruitless comparison; no such principle was found.

TABLE VII.

3 HYPHENED COMBINATIONS OF A TRISYLLABLE WITH ANOTHER WORD.

Word as in List.	As in F.	As in W.	Word as in List.	As in F.	As in W.
connecting-rod........	-	#	opera-glass..........	-	#
heat-energy..........	-	#			

No solid-word combinations having at least one trissyllable were found and the three given above are all that occurred hyphened. Of these *connecting-rod* and *opera-glass* occurred also as two-word combinations.

TABLE VIII.

29 TWO-WORD COMBINATIONS OF A TRISYLLABLE WITH ANOTHER WORD.

Words as in List.	As in F.	As in W.	Words as in List.	As in F.	As in W.
air compression.......		#	illuminating gas......		#
cantilever bridge......	#	#	inductance coil.......	-	#
caterpillar tractor.....		#	induction coil.........	-	#
canary wood.........	#	#	motor generator......	-	#
collector ring.........		#	motor interruptor.....	-	#
condensing engine.....	#	#	platinum metal.......	#	#
connecting rod........	-	#	power component.....	-	#
current density.......	-	#	resistance box........	-	#
cylinder condensation..	-	#	resistance thermometer		#
fire department.......	#	#	riveting machine......	#	#
flux density..........		#	steam cylinder.......	-	#
gravity cell...........	-	#	storage battery.......	-	#
hammer break........	-	#	surface condenser.....	#	#
hedgehog transformer..	#	#	vector quantity.......	#	#
hydrogen peroxide.....	#	#			

In this table W gives all the combinations in the two-word form, and F gives a much larger percentage so than in the prevous tables.

In the complete list there are 285 combinations of this class, but those in tables VII and VIII are the only ones given in the dictionaries. The aversion of engineering usage to the hyphen in compounds of this class is still more decided than in case of the previous forms.

There seems to be but two conclusions that are clearly to be drawn from all these samples, (1) that two-noun combinations are freely used in modern engineering literature, and (2) that most of such combinations have the two-word form.

I have made further comparisons which there is no room here to state; but I may say that from the whole list it is plain: (1) that usage does not in the majority of cases observe the rule that a hyphen shall be used where the latter element denotes action upon the first, as in *stock holder, air compression, cotton press;* and (2) that the same is true of the rule requiring the hyphen to avoid the suppositions misleading in such cases as: walking beam, living room, walking stick—but usage does require the hyphen however in every case where its use is required to make the sense clear.

In connection with this paper I may add that some 15 years ago I made a collection of upwards of 7,000 two-word combinations and found then that in the newspaper, sciences, industries, etc., there were many more two noun combinations in the two-word form than there were of those hyphened; but that in pure literature the two forms about broke even. I was as unable then as now to discover any *rule* or *principle* that would explain why some of the words were hyphened and not others which seemed the same in principle of formation. I believe that in the end the hyphen will be used only with a definite meaning, and it is plain to see how this can be done.

A GENERAL ENGINEERING COURSE.

BY C. H. BENJAMIN,

Dean, School of Engineering, Purdue University.

Letters under date of March 4 were sent to seventeen representative technical universities, asking for information as to present or prospective courses in general engineering. By this was meant a course which for the first two years should be practically the same as the other engineering courses, but which in the junior and senior years should contain a selection of subjects from other courses embracing fundamental principles rather than special applications.

The answers to these letters show only two institutions which have such a course at present. Ohio State University has a course in general engineering, the first two years being in required fundamental subjects and the last two years being almost entirely optional. Some work in commercial engineering is included. Massachusetts Institute of Technology offers a course entitled general engineering. There is a pretty definite schedule under the direction of a special committee but some electives are allowed. "This course is designed to meet the needs of those who do not wish to specialize in any particular branch of engineering to the extent demanded by the regular engineering courses."

Cornell University formerly had such a course which was very successful and was discontinued solely on account of the death of Professor Hess who was conducting it. It has been consolidated with the course in industrial engineering.

Minnesota has just abolished a course of this kind which had been in operation several years, the reason given being that it had become a refuge for "lame ducks." There is a flourishing school of business at this university which offers some courses suitable for engineers.

The University of Michigan has certain group options covering from 12 to 17 semester hours in the senior year and among these are options called general engineering, science, including advanced work in mathematics, physics, chemistry, civil engineering, mechanical engineering, electrical engineering, astronomy, mechanics, mechanism, chemical engineering, political economy and sociology. In this option eight hours are free electives. A fifth year is contemplated and many of the technical subjects may be carried into this year, leaving the four-year course more general than at present.

Illinois is considering the development of a new training course for foreign sales engineers, which will be of a general character.

The University of Pennsylvania has the subject of a general course under consideration and the matter is now in the hands of a committee.

Several institutions have options or partial courses in industrial engineering which in some ways answer the demand for a general course.

The Pennsylvania State College has such a course leading to a degree, which includes management, organization, industrial planning and salesmanship.

Courses in economics and history are given in the junior year for all engineering students while in the senior year electives are offered in business law, corporations, transportation, money and banking and political science.

At Sheffield Scientific School the governing board is considering a course in administrative engineering which will include industrial management, labor problems, statistics, business law, etc.

The University of Pittsburgh is planning a course in general engineering which will probably be called executive engineering. This will be similar to courses in industrial engineering administered elsewhere.

Wisconsin had at one time a course in general engineering which did not prove satisfactory and which was accordingly abandoned. The course was specific the first two years but was largely elective in the junior and senior years. This tended to make it an easy mark for indifferent students. At present options are offered in economics, management, etc., to engineering students.

The State Colleges of Iowa, Kansas, Michigan and Nebraska report no movement in the direction of general engineering courses.

Rensselaer and Worcester are likewise reported as not contemplating courses of this character.

I take the liberty of quoting from one of the letters received, the opinion of a prominent professor of engineering in one of the larger institutions as the quotation seems to me to outline the situation very clearly:

"1. There was a time when specialized training in the various engineering branches was distinctly desirable, but at the present time, engineering is so far developed that a competent engineer needs a broad fundamental training in engineering. He will still be able to specialize if he desires after he has found out the particular phases of engineering which he is called upon to know in detail. Our present system of specialization along the lines of mechanical, electrical, civil, chemical and other engineering subdivisions is extremely narrow and tends to give a man a very small pedestal upon which we expect him to build a somewhat broader superstructure. In my opinion, the procedure should be exactly reversed.

"2. It is very well for a young man 19 years of age to labor under the impression that he wants to specialize along certain definite lines, but experience, of course, has shown all of us in the educational fields that this is a serious mistake, as a man of real capacity seldom follows the particular details upon which he specialized while at college. When he reaches 40 or 45 years of age and has become a man capable of assuming large responsibilities and has to associate with men of broad education and with large business and social opportunities, he begins to realize how seriously handicapped he is through his failure to take advantage of a more general education while in college.

"3. Unfortunately, today, we turn out in the majority of our institutions, a large percentage of men who will never be engineers. They belong to the general group of mechanics or mechanicians. This will probably always be true, but it seems a mistake to restrict and narrow the educational possibilities of the men who have the natural qualifications and capacity to handle an engineering course from a broader viewpoint than that of the mechanician.

"4. Realizing that courses in general engineering as tried at some other institutions had proved to be the waste basket into which lazy, inefficient men finally landed, thus giving the course a 'black eye,' I feel that if we introduce a course in general engineering, it should be somewhat on the following basis.

"Instead of being the waste basket into which men unable to maintain themselves in the regular engineering courses were allowed to drift, the course in general engineering should be placed on a higher plane then the detailed, specialized courses. Only a limited number of students should be given the privilege of taking the course. It should be regarded as a mark of distinction to be approved for this course.

"On this basis I believe that such a course could be made a very distinct success and would meet a very definite requirement of the present day."

Summing up the information received from seventeen institutions, we find *two* which administer courses in general engineering at the present time, *three* which have had such and abandoned them for divers reasons and five which have a course of this character in contemplation.

In this last group some will probably adopt a course rather of the industrial than of the general type.

The following conclusions seem warranted by the data:

(*a*) The need is felt of a certain amount of general engineering and business training outside of the usual curriculum.

(*b*) This need is to a degree met by the use of options and electives in the junior and senior years.

(*c*) When a fairly liberal course in administrative or industrial engineering is open to students, the need of the general course is not so evident.

(*d*) The failure of general courses in the past has been due to the lack of a rigid, well planned course and to the over liberal use of options.

(*e*) The subject of giving a broader training in engineering is one which is being largely considered by many of the leading technical institutions.

GEORGIA TECH SECTION.

BY R. R. KIRK,

Secretary.

Members and friends of the Georgia School of Technology Section of the S. P. E. E. were addressed recently by Mr. S. C. Coler of the Westinghouse Electric & Manufacturing Co. on "Opportunities for Technical Graduates in the Electrical Field." Mr. Coler also called attention to some of the weaknesses of the technical graduate from the employer's point of view.

America is taking her predestined place in world affairs; she is sending out increasingly her raw materials and her manufactured products; ships must be built and outfitted with improved machinery; harbors and docks must be built; the demand is to be increasingly great for men of resource and education to develop production and transportation to their utmost.

The speaker believed that teachers in technological schools should emphasize fundamentals and also the economic aspects of engineering. Specialization can be overemphasizezd. The demand is for engineers, not for C.E.'s, M.E.'s, etc.

The young engineer is often found to be lacking in the following particulars: In native ability of the engineering kind; in judgment in practical matters; in a knowledge of men that enables one to work with them, and especially with workmen; in a comprehension of the position occupied by the engineer in industrial society; in the ability to measure values; in observation; in originality; in the sort of courage which enables one to accept responsibility; in a knowledge of business ethics; in a proper conception of the importance of health as a factor in success.

These were presented as matters for teachers of engineers to consider. Some of them, it was believed, might be to some degree corrected by the teacher; others are perhaps beyond his control. But the teacher's aim should be to prepare his students to take part in a work calling more and more insistently for originality, resource, breadth of view, and a genuinely scientific knowledge of fundamentals.

METHODS OF PREPARING REPORTS FOR TESTS IN ENGINEERING LABORATORIES.

BY H. H. FIKRER,
Assistant in Mechanical Engineering, University of Illinois.

One of the most important and to a great extent puzzling problems, with which those of us who are selected to guide the destinies of an engineering laboratory, is the matter of deciding upon a correct method of reporting a test. If the writer is to judge by his experience and his association with the laboratory staffs of some four or five of our state universities, it can be safely said that at the beginning of each college year the main question to be discussed at the first staff meeting, is the one concerning report writing. Needless to say that a great many systems have been adopted and pursued for a year or two and then abolished for the reason that the personnel of the staff has changed and consequently the method of the "older fellows" must be done away with. Thus it is seen that it is greatly a matter of opinion.

It is worth while to review briefly the outlines of some arrangements used in certain laboratories from time to time, and discuss the merits and shortcomings of each.

Remembering that the students are to be taught the proper method of complying a report of a commercial test, the following form may be considered.

The report should be headed with some conventional form of introduction as given below:

TO THE EXPERIMENTAL ENG. LAB.,
DEPT. OF MECH. ENG.,
THE UNIVERSITY OF XYZ.

XYZ/, A
Sept. 1, 1917.

Gentlemen:

I would respectfully submit the following report on ————
(State here the title of the experiment)

1. *Object:* State clearly and concisely the object of the experiment, and give the date on which the work was done.

2. *Apparatus* (*a*) Apparatus tested. Describe in a genral way the apparatus tested, making use of sufficient diagrams, photographs, blue prints, or sketches to make clear the arrangement of the apparatus. Where diagrams, etc., are used, give each a title, letter its parts, and refer to those parts by letter. All diagrams aid sketches should be in ink, not pencil.

3. *Method:* Describe the method of performing the experiment or test, in making the test, describing any special forms. Where it seems desirable, make use of photographs, diagrams, sketches, etc., as above.

3. *Method:* Describe the method of performing the experiment or test, telling exactly what was done in carrying on the work.

4. *Data:* Tabulate all data (this refers especially to observed data) in neat form in ruled columns on a separate sheet or sheets. Provide a proper explanatory title to each table, and head each column with name of observation and the unit in which it was measured.

When indicator cards are taken, always include sample cards, firmly and neatly attached to a standard-size sheet, giving on each card enough data to identify it completely.

5. *Results:* Under this head should be included:

(*a*) Formulæ used, explaining how they are derived.

(*b*) Sufficient computations with all operations indicated, so that the method of obtaining all results may readily be understood.

(*c*) Final results in tabular form.

(*d*) Curves where desirable, showing graphically the results obtained. These should be plotted on 8½ x 11 coördinate paper, punched on the left-hand side. Each sheet should be labeled, unless otherwise directed, take the dependent variable as ordinate, and as a rule place the zero of the curve on the curve sheet. Print the legend for the abscissa horizontally and that for the ordinate vertically, so that each reads away from the orgin. Always state the unit in these legends. Plot the curve to a reasonable scale, indicating the observed (or calculated) points by means of small circles, squares, etc. Usually a smooth curve does not have to go through all the points.

6. *Discussion:* Give a brief summary of the experiment, calling attention to the most important results obtained. Discuss any peculiarity of the results themselves; if too high or to low, discuss possible causes. Discuss anything tending to prove or disprove doubtful data. State what your results prove. If any laws are developed, state them. Compare with theory and standard practice and state whether or not the machine or equipment tested has fulfilled special requirements. In every case where quotations are used, the name of the authority quoted, and the reference, should be given. Respectfully submitted,

(Signature).

The above form is no doubt one that if carefully and completely followed out by the student will result in a satisfactory report. The most important element, however, which plays a large part in adopting a form such as the one under consideration, is time. If the student is to write such a report on every test that is run during the entire semester, will he be devoting such a large portion of his time to his laboratory course that he must necessarily let some other course "slide?" This has been the case at times. In order to take care of this point the above long and complete form could be tested to only a few of the tests made, say 2 or 3 during the semester. In that case it would be best to require this long form to be applied to one of the first tests in the course, then one about the middle and one towards the end of the semester, in order that the student may profit by the corrections made to the previous report. Another way to require less outside time from the student in preparing such a report is to allow him a number of laboratory periods after the period in which the test was run, to compute the results, plot curves, make sketches and diagrams, leaving only the descriptions of the apparatus, method of procedure and discussion of results to be written during study hours outside of the laboratory.

It is interesting to notice the conventional form of introduction used in the above outline. While some such beginning would be essential in commercial reports, the opinion of the writer is that a letter would accompany the report when it is submitted and contain this section more properly.

Under the title of Apparatus it will be seen that photographs are made use of. While photographs of the unit tested equipped with the testing apparatus provides a very convenient means of showing the set up of the test, it is very doubtful whether the student profits to any large extent from examining the photographs, marking the various parts with different letters and tabulating the names of these parts corresponding to the letters placed on the picture. Opinions differ on this point very greatly, and the writer begs to discuss this part of the report by merely submitting his personal opinion. Experience has shown that requiring the student to draw a line diagram of the unit or units tested showing pipe lines, belting and similiar attachments, while requiring a considerable amount of time, is liable to be of greater service in giving the student a better knowledge of the equipment he tested than a photograph would. To save time, a cut of the line diagram of the apparatus tested can be supplied to the student, which would appear in the final report. In a number of laboratories neither a photograph or a line diagram is used. In deciding the necessity of using some kind of a cut of the apparatus tested, it should be remembered that the function of laboratory instructors is not merely to have the students take readings of pages, thermometers, speed counters, and the like and then proceed to the computing room and make his calculations. This only constitutes a small part of the work, for the student usually is taught in some previous theoretical course how to make these computations. A great deal of attention should be given to the methods of taking readings, the function of each measuring device used, the way in which that device is connected and its point of location, so that the student may learn just as much on the laboratory floor as he does in the classroom. One of the main weaknesses of our present laboratory systems is that everything is made ready for the student, so that he never gets any experience in preparing a machine for a test, nor is it impressed upon him that making preliminary tests are absolutely essentials. In fact in many cases the student is not acquainted with the method of starting and stopping the machine he is testing. Is it any wonder then that some of our graduates would be completely at sea if he were to be obliged to organize a test and make a report of his work? It must be admitted that to cover the various types of machines in a certain line, a large number of tests must be made during the time allotted to laboratory practice, but no doubt it would be more advisable and essential that to make fewer tests and spend enough time on each test for the student to receive a complete understanding of the test methods employed, and the general purpose of the test, rather than have a large number of tests and devote a very small amount of time to essential fundamentals. The modern trend in the revised engineering courses is not to devote a great deal of time to specialization, but to give the student a good, solid, general fundamental course in engineering upon which he may build after he finds his choice for specialization when he has had more of the particular kind of experience necessary in that field. It seems that some such reasoning may well be applied to laboratory practice, for one who is familiar with methods of testing, and who has been taught to cultivate accuracy and neatness in work, is much more liable to make a success as an experimentor than one who has specialized in testing a certain line of machinery, or one who has had in his training been allowed to make tests of a large variety of machines, but has little knowledge of fundamentals.

The third part of the outline is no doubt essential whether a mere laboratory or a commercial report. Methods used in conducting the test must be explained if one is to be able to account for certain points in the results which may not be self-explanatory.

Passing on to the fourth part, we come to a very important point. The matter of teaching students how to take neat and accurate readings is by no means an easy one. The observed data or the data taken on the test should be kept on sheets as specified in the form under consideration. One of the best methods of taking the readings is to provide a general log sheet, on which should appear neatly tabulated all the readings taken during the test. In case a complete report is to be made of the test, a tracing and blue print can easily be made of this log sheet and each student on the test be provided with a copy. Furthermore having all the data on one sheet, where it can be totaled and averaged, diminishes the chances for one or a few of the various station logs sheets to get lost and therefore make the whole test useless. Without further discussing the above form, it is worth while to consider very briefly the following outline:

"*Section 1.* This includes:
- (*a*) Object of the test.
- (*b*) Performance guarantees which the equipment is supposed to meet.
- (*c*) Summarize the most important test results, and state your conclusions concerning same.

"*Section 2.* This includes:
- (*a*) Curves or graphical log sheets.
- (*b*) Data and results sheets.

"*Section 3.* This includes:
- (*a*) Description of test including the apparatus as tested and the methods employed in testing, also sketches and diagrams.
- (*b*) A brief discussion of any special methods used or unusual conditions existing during test.

"*Section 4.* This includes:
- (*a*) Sample calculations.
- (*b*) Indicator cards."

It will be seen that this outline is similar to the one previously presented, containing almost the same items and differing only in the matter of arrangement.

The writer would recommend this arrangement as in his opinion it represents more nearly a commercial type of report if complied in the order shown. Attention could be called to Section I. part (*b*) and part (*c*), which did not appear in the first outline considered. The advisability of stating the guarantee which the equipment is to come up to goes without saying. One who is in the position of buyer, no doubt ought to be informed of the guarantee under which the particular piece of equipment is to be sold.

Part (*c*) is more or less an answer to part (*b*). This section should not contain any more results than what is included in guarantee. If part (*c*) contains the proper results and a precise conclusion includes a recommendation concerning the equipment, the rest of the report may in many cases become a minor part.

Section 2 in two parts contains what is no doubt the next important section of a commercial report. If one is not convinced by the contents of section 1 and has a desire to further investigate; parts *a* and *b* of section 2 will no doubt give valuable information and show the performance of the machine, tested.

Sections 3 and 4 are contained in the form previously discussed. The only difference is the order in which they appear. Section 3 is essential as far as a complete report is concerned, but could be omitted from a commercial report but must be included in a report made by students if the instructor is to be able to trace out an error.

Part (*b*) of Section 4 of course should be included in either case.

The above discussion does by no means exhaust the subject and solve the problem. Conditions, such as the number of hours devoted to laboratory work, the equipment available for testing, and the theoretical courses a student takes in his curriculum has a great deal of effect. With the amount of time usually available for laboratory work the student can not be taught correct English. It would be advisable to have a course some where in the students' schedule when he can be taught to compile a commercial report. This course for engineering students, should deal with engineering subjects and preferably should be taught by one who has made a study of writing engineering reports.

The courses taught in the class room when the theory is expounded upon the apparatus the student is to test when he enrolls in the laboratory course, should so correlate with the laboratory course that time ought not to be spent in the laboratory in repeating the theory. The matter of corrolation is important and it is safe to say that one can easily find a good deal of repetition in courses at the present time.

PRELIMINARY REPORT OF THE COMMITTEE NO. 11–A, PHYSICS.

The work of the Committee of Physics has reached a stage where a review of its endeavors should be given and a recommendation made to the Society for future action. The present Committee was appointed in 1916. It found that its predecessor had presented an excellent report which contained the results of a survey of the courses in physics in the various engineering colleges and certain important recommendations. Your Committee proceeded to ascertain in what direction the greatest assistance could be rendered to instruction in physics and it decided that correlation of the course in physics with subsequent courses using the fundamental principles of physics would be the most valuable contribution the committee could make in the work of the Society.

On March 15, 1917, the Committee on Mechanics, through its chairman, Professor E. R. Maurer, agreed to a joint effort in coöperation which may be described as the "preparation of a syllabus on mechanics" as a highly "desirable method of influencing the coöperation which should exist between the two courses in mechanics." The Committee on Physics was to prepare the physics portion of the syllabus and the Committee on Mechanics was to prepare the material for the course in mechanics. The order of presentation of the topics of the syllabus was to be merely that of convenience, emphasis being placed on subject matter rather than upon order of presentation.

The Committee on Physics prepared its portion of the syllabus which was submitted to the Committee on Mechanics on December 6, 1917. The form of the "Content" was an alphabetical list of subject matter, with all formulæ, units and even the nature of the problems, the latter appearing each one in its appropriate place. Suitable cross references were made, so that it was possible to ascertain quickly just what was supposed to be taught in the first general course in physics on the subject of mechanics. The effort of the Committee was to be brief, to be concrete and specific, to avoid "methods of presentation" and the arguments resulting therefrom and to furnish a clear picture of what should be expected of the first course in physics. In the relatively brief time between December, 1917, and June, 1918, no report was made by the Committee on Mechanics to the Committee on Physics as to the progress of the proposed syllabus.

On December 19, 1918, the Committee on Physics resubmitted the "Content" to the new Committee on Mechanics and Hydraulics, recently appointed. The latter Comittee considered the original proposal and reported back to the Committee on Physics on May 19, 1919, that the Committee on Mechanics and Hydraulics seemed to be in favor of coöperation. No further report was had from this Committee until the chairman of the Committee on Physics requested a conference with the Chairman of the other Committee. Then the latter consulted with a member of his Committee and several others and formulated a tentative report indicating that the coöperation as proposed was inappropriate. But later, on May 3 and 4, the chairman of the two committees had an extended conference which very naturally brought about a better understanding as to what the Committee on Physics hoped to accomplish by its plan of coöperative effort. The chairman of the Committee on Mechanics and Hydraulics, Professor O. H. Basquin, was not convinced that the exact plan proposed by the Committee on Physics was the best to be had. No future plans were laid as to a joint action of the two committees because of the short time remaining before the annual meeting.

The Committee on Physics wishes to present to the Society briefly its defense of the plan of coöperation described and the possibilities of correlation arising from its application. The basis of the argument presented briefly, and hence inadequately, is as follows:

1. All efforts at coöperation must have as a basis relevant facts; this is the starting point of all endeavor in which the scientific method is used.

2. The most important information that should be available as a basis of coöperation in and consequent correlation of the two courses of mechanics, is the *content* of the two courses.

3. Such information should be in reference form. This could be accomplished by the completion of the alphabetical topic list described above, the "content" of the mechanics course being placed perhaps in a parallel column with the content in the physics course. This would make the information desired available with a minimum expenditure of time.

4. From such information immediately would arise definite possibilities of correlation as illustrated by the following attainments:

(*a*) The securing of more appropriate emphasis in the physics course.

(*b*) The saving of time and improvement of results in the mechanics course through the utilization of review as such. Other possibilities will occur at once to a teacher in either course.

The chief arguments against the form of coöperative effort proposed are as follows:

1. Instructors in mechanics and physics are fairly well satisfied with conditions as they are. The reply is that it is not the satisfaction of the instructor in which the Committee should be interested, but the fact that the student takes two succeeding courses in the same subject between which no effort at correlation has been made by the Society.

2. Coöperation can be had in any institution where the instructors desire it and such a plan as proposed is not necessary. The answer is that the Committees' work is that of the Society, that, truly, the Society is not necessary, but that each

Committee should endeavor to make the Society as effective as possible in improving engineering education.

3. Instead of the proposed plan it may be better to formulate a general plan and let each institution carry it out as suits individual preference. The answer is that the Committee on Physics does not favor advice, but rather a constructive piece of work of a concrete character, believing that this is a kind of a contribution that the Society should make.

In this connection, your Committee calls attention to the fact that at the Virginia meeting in 1916, it was moved by Professor Greene, seconded and carried, that "It is the sense of this meeting that the Committee on Mechanics in the preparation of its syllabus hold conferences either by letter or at meetings with the Committee on the Teaching of Physics."

A further word in reference to correlation might make clearer its meaning and its need. Correlation between courses articulates instruction by eliminating gaps and inconsistencies between them. It makes the work more interesting to the student and it tends to economy in his time. It enables an instructor to do better work; it gives him definite information regarding the previous intellectual attainments of his students, and it shows him what they will be called upon to do in future courses. He is able, therefore, to give them instruction that is adapted to their preparation, and to the demands of other instructors. He is able to review old material as such and thus greatly aid its retention by the student.

Moreover, the instructors in any one department develop departmental ideals and traditions, and methods of teaching and establish the ground covered largely independent of other departments; they feel pride in their own department; they concentrate upon their own work; they think they have not time to understand the points of view of other departments. A feeling of mutual distrust naturally arises and some degree of isolation ensues; isolation is the opposite of correlation.

Your Committee wishes to express the opinion, based upon the thought given the matter and upon its experience in working with another Committee, that the correlation of the course in physics with subsequent courses in which the fundamentals of physics are used is highly important; that the Society should appoint a Special Committee for the purpose of making a report upon the subject; that this report should describe the desired correlation in mechanics in such a manner that the report can be applied directly without requiring each institution to work out, ab initio, its own plan, that the report should be concrete in at least one subject, mechanics, and that it include a statement of the practicable ways and means of securing correlation in other subjects as well.

Your Committee therefore recommends that the Society authorize the appointment of a Special Committee whose duty shall be to make a report upon the correlation of the course in physics with subsequent engineering courses, particularly that in mechanics.

PRELIMINARY REPORT OF COMMITTEE NO. 12, ENGLISH.

The following communication was sent to deans and heads of English departments in the various engineering colleges represented in the S. P. E. E. membership. As will be noted from the topics given, the object of this particular inquiry was to learn the policy of the several institutions with regard to English literature and to other non-technical subjects more or less closely related to the work of the English department. Topic No. 6 belongs to a separate investigation, on which a special report will be made at the 1920 session of the Society.

To the Dean or the Head of the Department of English in the Engineering College.

The Committee on English of the Society for the promotion of Engineering Education wishes to ascertain as fully as possible the present status of what may be called "liberal" studies, and particularly those which are directly in charge of the English Departments in the various Engineering Colleges. Although part of this information is found in the college catalogues, it is desirable that the brief official announcements be supplemented with statements of policy and procedure. To this end, the Committee would like to have not only statistical data but also comment from those who are responsible for the curriculum. The suggestions given below should therefore be regarded as an invitation to discuss these and other phases of the subject, and not as a questionnaire to be answered briefly and categorically. The Committee will be glad to have replies reach the Chairman if possible before May 10, 1920. Supplemental answers after that date, however, will be acceptable.

1. Amount of time given to literature and literary composition in the course in engineering.
2. Recent changes of policy, if any, affecting the amount or character of instruction in humanistic subjects. (Include History, Political Science, etc.)
3. Most successful methods which have been found for presenting the "liberal" or broadening subjects to engineering students.
4. Attitude of students toward such instruction.
5. Attitude of instructors in Technical Departments.
6. Qualifications sought in a teacher of English for Engineering students.

COMMITTEE No. 12,
C. W. PARK, *Chairman,*
University of Cincinnati,
FRANK AYDELOTTE,
Massachusetts Institute of Technology,
SADA HARBARGER,
Ohio State University,
J. R. NELSON,
University of Michigan.

SYMPOSIUM ON "LIBERAL" STUDIES FOR ENGINEERING STUDENTS.

Statistical matter will be included in the later report, but for this brief preliminary statement, it seems advisable to cite only general expressions of attitude and policy. In order to stimulate discussion, a symposium of typical comments complied from the answers is here presented:

Parallel with the course in English during the Freshman Year runs a course in the History of Civilization. In the Sophomore Year Political Science and History of Recent Times are parallel courses to the English course. In this way we have successfully introduced certain "liberal" subjects into the engineering curriculum. Following these courses, the thread of liberal subjects is maintained during the Junior and Senior years by couses in Economics, Logic, and Psychology. The method found most advantageous is the lecture. It is a relief to engineering students from their mathematical, physical, and shop studies, to attend once or twice a week a good lecture on some liberal, broadening subject.

The instructors in charge of these courses do not hesitate to introduce outside matters into the courses when some topic appears to be of value to the students.

The attitude of the students towards such instruction is very good. The upper-classmen are especially fond of these two lecture hours per week. The instructors in all the technical departments are also very sympathetic towards these courses. Upon the whole, they have proven very attractive both to students and faculty and they have had a marked success in our institution.

Dean Morrison,
Armour Institute of Technology.

The most successful methods for presenting "liberal" subjects to students in the Engineering School have been found not to differ, in any essential respect, from those adopted in dealing with students in the College of Arts.

Students in engineering are responsive to liberal studies and their work compares favorably with that done by students fom other schools. It is not true, as sometimes stated, that undergraduates in technical schools are hostile to humanistic subjects.

The spread, among the most influential members of the profession, of enlightened views with respect to the function of the engineer as a responsible member of society is wholly favorable to the promotion of liberal studies in technical schools and is already having its effect on the attitude of both instructors and student body. It is perhaps needless to point out that the movement will probably prove retroactive and that, by the infusion of broader ideas, the teaching of technical science itself will ultimately be informed with a more liberal spirit than has characterized it hitherto.

Professor Daniel E. Owen,
Department of English, Towne Scientific School, University of Pennsylvania.

We should like to increase the amount of time given to this subject and we hope to be able to do so in the near future. The difficulty in the way is the crowded condition of the time-table, rendering it hard to find additional time without unduly burdening the student. We have recently extended our course on Economics in the Faculty, and have included in it certain subjects which are sometimes classed under the head of Political Science.

It is somewhat difficult to convince the students of the necessity of the study of the English language, since they are apt to feel that purely technical subjects are more important. I think, of recent years, however, by clearly putting the facts of the case before them, that students have been won to a more general appreciation of the importance to them of possessing a good knowledge of their own language and of acquiring the ability to use it.

FRANK D. ADAMS, *Acting Principal*,
McGill University.

The attitude of the instructors in technical departments toward English and Economics is altogether friendly. Every one realizes the importance of the subject. There are some differences of opinion as to how they should be taught, but every one believes in them as a necessary part of the engineer's training.

DEAN RAYMOND,
Iowa State University.

I understand by "humanistic elements" those elements in the course which would tend to broaden the student's general knowledge and to interest him in subjects outside his immediate technical fields. In the first place, throughout the course in Freshman English every effort is made to induce the students to do general reading, as we call it, in a rather large selected library of first-rate books. In general, students are encouraged to choose their reading as suits their inclination from this highly selected library. We do, however, attempt to induce the student to read in different fields and in different types of literature, so that by the end of the year he will have had a taste of various kinds of writing and some initiation in different fields of thought. This reading of which I speak is included under what is generally called "collateral reading." Within the course itself the liberal elements are less represented in the first semester than in the second, since our effort in the first semester is necessarily directed toward overcoming the student's elementary faults in composition. Still even in the first semester a considerable amount of good selected expository reading is associated more or less closely with the class work. It is in the second semester, however, that the liberal elements in the course are chiefly represented. The course in the second semester consists, on the one hand, of a regular scheme of theme writing, one theme weekly, and on the other hand, in the accompanying reading of a limited amount of classical English prose. In the current semester this prose consists of the first chapter of Matthew Arnold's "Culture and Anarchy," Emerson's "Self-Reliance," an essay of Ruskin's and an essay of Stevenson's. This limited amount of reading is read in the classroom with uncommon minuteness and much opportunity is given for the discussion of ideas which may arise. Through this means students are bound to come into contact with a considerable variety of important ideas, ideas which not infrequently are made the subject matter of their own compositions. I should add perhaps that we are extremely prudent in making use of his subject matter for work in composition, since we insist on the student making direct application to his own experience of the ideas which he presents.

PROFESSOR FREDERICK A. MANCHESTER,
Department of English, University of Wisconsin.

The principal change in the administration of English is the examining of Freshman students on entrance and the placing of those deficient in English in a separate class. As a rule, these deficient students would be debarred from foreign language and would be required to take additional work in English. There is a decided tendency at present toward giving more opportunity to students in the Junior and Senior years for the study of the so-called humanities and to offer courses in technical English, and Industrial Economics which shall apeal to engineering students; these latter, however, to be mainly elective.

It seems to me success in teaching these subjects to engineers depends on making them more applicable to their particular work and giving practical applications in connection with the course. The student will much more readily take technical or journalistic English than a course in English poetry and prose.

The attitude of the student is not hostile but rather inclined to be utilitarian. He usually lacks interest in a subject whose application he can not foresee.

The general attitude of instructors in technical departments is favorable to broadening of the engineering course, as they realize from their own experience the deficiencies which handicap the engineer at present.

DEAN BENJAMIN,
Purdue University.

I have noted no especially successful method for presenting "liberal" or broadening subjects to engineering students. As a matter of tactics, rather than method, I believe in presenting the opportunity for such work to engineering students in their Junior and Senior years rather than earlier. The opportunity is then much more likely to attract them.

Upper classmen in engineering are, to a very large extent, willing and even desirous of studying other than technical subjects, if the opportunity for such study can be found. First- and second-year men are generally either indifferent or disposed to avoid as much as possible contact with other than engineering subjects.

Instructors in the technical departments are, in general, favorable to broadening the engineering curricula if possible but have come to the conclusion that a four-year course offers little opportunity for such broadening except at the expense of essential technical subjects.

DEAN STOUT,
University of Nebraska.

Recent changes in policy include:

(*a*) The increase of required work in English. I believe the amount of such work as shown in (1) is unusually large, being about ten per cent. of the total work required for graduation.

(*b*) The introduction of a required course in Citizenship, 3 hours a week, for one term, in the Junior ear.

(*c*) The introduction of an elective course in Modern European History, 3 hours a week for one term, in the Junior year.

Informal lectures, assigned reading and written discussions.

Students are inclined at first to minimize the value of the liberal studies, but later on show considerable appreciation.

DEAN PURYEAR,
Texas A. and M. College.

A majority of the older men on the faculty of the College of Engineering desire that our students take up seriously work in English, philosophy, economics, psychology, sociology, etc. I know that many of us urge them to give some consideration to questions not regularly incorporated in the engineering curricula, but which are of interest to well-educated men.

DEAN RICHARDS,
University of Illinois.

Question No. 3: Since these subjects belong to the College of Arts and Science primarily and very few engineering students take them in proportion to the total enrollment in such courses, the methods of presenting these subjects have usually been as customary for Arts and Science students with little attempt to adapt them especially to the needs of technical students. This will not be true of the new course, Introduction to Economics, which is designed especially for engineers.

The attitude of instructors in technical departments: Most of our engineering instructors are glad to have the students elect the above types of courses, but there has been little disposition to attempt to cut down the requirements in technical courses to make room for the more liberal electives.

Acting Dean Boardman,
University of Nevada.

Most successful methods which have been found for presenting the "liberal" or broadening subjects to engineering students: The most successful methods which have been found are the employment of really first-class professors to give the workmen who know what they are teaching and have personality which will inspire the students. In addition we conduct what might be described as almost a propaganda to influence students to enter these lines of work.

Attitude of students toward such instruction: The attitude of the students generally reflects the ability with which the work is presented. There seems to be increasing interest of engineering students in broader and more liberal training. Left to themselves, engineering students are slow to see the merit of non-technical work.

Dean Marston,
Iowa State College.

There is a wide variety of opinion as to the best methods of presenting the so-called liberal subjects to engineering students, but there is unanimous agreement on one point and that the first essential is a sympathetic attitude on the part of the teacher toward the aspirations of the student, whatever they may be. If they are not of the highest type, this sympathetic view point is absolutely necessary to enable the teacher to lead the student into some other and better state of mind.

Dean McCaustland,
University of Missouri.

Besides the liberal studies as indicated above, we are encouraging our engineering students to take additional work in English, history, civics, and journalism. The records in my office show that at least three-fourths of the engineering students who have graduated during the past four years took one or more additional courses in the above liberal studies. Our engineering students are particularily interested in adding to their assignments such subjects as business English, advertising, oral English, money, and banking, sociology, technical journalism, and Spanish. Our students seem to show a splendid attitude particularly during their junior and senior years towards the so-called liberal studies, and we have little difficulty in convincing them of the importance of adding as many such subjects as possible to the required subjects in their curriculum.

Dean Potter,
Kansas State Agricultural College.

The tendency recently has been to introduce as much elective work in humanistic studies as is possible in the rather rigid confines of the engineering courses. On page 28 of the current catalog you will see that economics is required of the juniors in the C.E. course and that six hours of electives are open to seniors, three being required. Formerly very little choice had been given here.

After many years of experimenting I have found that the most successful method of presenting literature and advanced English reading is to get the message home and to treat technique only incidentally. I never lose sight of the fact that the men are training to be engineers but I also assume that they have certain definite human and social interests through which literature can be made to appeal to them.

Professor James W. Tupper,
Department of English, Lafayette College.

With grateful acknowledgment of the coöperation of the men whose remarks are quoted above, and of others whose contributions will be noted in the later report. The Committee submits the foregoing preliminary statement.

C. W. Park, Chairman.

COMMITTEE NO. 22, INTELLIGENCE TESTS.

The report of Committee No. 22 on Mental Tests for engineering freshmen, which will be presented at the June Convention of the Society, will not be ready in time for the May issue of the Bulletin. However, the report will be similar to that which has already been prepared for the engineering freshmen at Carnegie Institute of Technology. This local report is therefore submitted for the May Bulletin as a sample of the type of analysis for which the data from all the forty-eight participating colleges is now being studied. The convention report will be a summary of the various local reports.

COMMITTEE NO. 22, INTELLIGENCE TESTS.

REPORTS OF MENTAL TESTS IN THE DIVISION OF ENGINEERING AT CARNEGIE INSTITUTE OF TECHNOLOGY, PITTSBURGH, PA.

Freshmen, Autumn Quarter, 1919.

This report concerns the findings in the six tests that were given the engineering freshmen under the auspices of the Society for the Promotion of Engineering Education. It has special reference to the standing in the tests of those students who have dropped out from college for various reasons during the first quarter. It is therefore only a preliminary report. The complete records of withdrawal for the first year will be evaluated next summer. The scholarship records for the first quarter will be evaluated in terms of points for quality and the relationship between points for quality and the test scores will be compared as soon as the quality points are available.

We are here interested in knowing particularly the test scores of the students who dropped out for poor scholarship, those who were transferred, and those who withdrew for other reasons.

The results are listed for each of the six tests separately and also for the six tests combined. The interpretation of the table is as follows:

Test I (Arithmetic Problems) was given to 473 students. After scoring these test papers the class was arranged into four quarters according to this test. This divides the class into four equal quarters with 118 students in each quarter as indicated in the table. Note that of the 44 students dropped for poor scholarship during the autumn quarter 25 of them are found in the lowest quarter, 10 in the third quarter and only 4 in the highest quarter. These figures are found in the second column.

The third column shows the distribution of the students transferred to the Industries School. Of the 16 students so transferred, 12 were in the lowest quarter of the Arithmetic Problems Test and 3 were in the highest quarter.

Of the 37 students who were withdrawn for reasons other than scholarship, 18 were in the lowest quarter according to the Arithmetic Test while only 3 were in the highest quarter. These facts are found in column 4.

TABLE I.

	1. Total in Each Quarter of the Class.	2. Dropped for Poor Scholarship.	3. Transferred to Other Departments.	4. Withdrawn for Other Reasons.	5. Probability of Remaining in Good Standing at End of Three Months.	6. Total Withdrawn.
TEST I, ARITHMETIC:						
Highest quarter	118	4	3	3	91	10
Second quarter	118	5	0	8	89	13
Third quarter	118	10	1	8	84	19
Lowest quarter	118	25	12	18	53	55
TEST II, ALGEBRA:						
Highest quarter	118	4	4	8	87	16
Second quarter	118	3	1	4	93	8
Third quarter	118	24	1	6	74	31
Lowest quarter	118	13	10	18	65	41
TEST III, GEOMETRICAL CONSTRUCTION:						
Highest quarter	116	2	0	4	95	6
Second quarter	116	4	4	4	90	12
Third quarter	116	13	5	11	75	29
Lowest quarter	116	23	7	12	64	42
TEST IV, INTELLIGENCE:						
Highest quarter	118	5	3	5	89	13
Second quarter	118	5	0	7	90	12
Third quarter	118	15	6	12	72	33
Lowest quarter	118	19	7	13	66	39

In column 5 we have the probability of remaining in good standing at the end of the autumn quarter. This is simply the ratio of the number of students in good standing to the total number of students. This ratio has been calculated separately for each of the four quarters of the class. Thus, the probability of remaining in good standing is 53 per cent.

for the lowest quarter and 91 per cent. for the highest quarter. *This means that if a student is in the lowest quarter of Test I, Arithmetic Problems, his chances are 53 out of 100 of remaining in good standing at the end of the autumn quarter. On the other hand, if a student is in the highest quarter of his class in Test I, Arithmetic Problems, his chance of remaining in good standing at the end of the autumn quarter is 91 per cent.*

TABLE II.

	1. Total in Each Quarter of the Class	2. Dropped for Poor Scholarship.	3. Transferred to Other Departments.	4. Withdrawn for Other Reasons.	5. Probability of Remaining in Good Standing at the End of Three Months.	6. Total Withdrawn.
TEST V, PHYSICS:						
Highest Quarter	118	5	0	6	91	11
Second Quarter	118	10	0	6	87	16
Third Quarter	118	8	5	10	81	23
Lowest Quarter	118	21	10	14	62	45
TEST VI, GENERAL TECHNICAL INFORMATION:						
Highest Quarter	118	5	0	8	89	13
Second Quarter	118	11	2	2	87	15
Third Quarter	118	10	4	7	82	21
Lowest Quarter	118	17	9	19	62	45
RANK ACCORDING TO MID PERCENTILE OF ALL SIX TESTS.						
Highest Quarter	116	2	1	5	93	8
Second Quarter	116	5	0	7	89	12
Third Quarter	116	13	3	5	81	21
Lowest Quarter	116	24	11	19	53	54

In column 6 we have the total number of students withdrawn for various reasons and their frequency of occurrence in the four quarters of the Arithmetic Test. *There are five times as many students withdrawn out of the 118 in the lowest quarter according to the Arithmetic Test as in the same num-*

ber of students in the highest quarter according to the Arithmetic Test.

There are six times as many students dropped for poor scholarship in the lowest quarter of the Arithmetic Test I as in the highest quarter of the same test.

The same type of analysis is carried out for each of the six tests. *Thus in Test II, Algebra,* we have 13 students dropped for poor scholarship from the lowest quarter of this test whereas only 4 were dropped for poor scholarship in the highest quarter of the Algebra, Test II.

Test III, Geometrical Construction, is one of the best tests in the series. If we divide the class into four equal groups based on the score in Test III, Geometrical Construction, we find that *23 students were dropped for poor scholarship out of the lowest quarter in the Geometry Test whereas only 2 were dropped from the highest quarter.* There are 10 or 12 times as many students dropped for poor scholarship from the lowest quarter of this test as from the highest quarter. These facts are shown in column 2 for Test III.

In column 6 for Test III we find that 42 students in the lowest quarter of Test III withdrew for various reasons whereas only 6 students from the highest quarter withdrew.

From column 5 for Test III we find that if a student ranks in the highest quarter of his class in the Geometrical Construction Test the chances are only one in 20 that he will withdraw for any reason during the first three months. But, if the student ranks in the lowest quarter of his class his chances are 13/20 that he will withdraw during the first three months.

If we arrange all the scores in the *Intelligence Test IV* in order from the highest to the lowest for the freshman class and then divide the class into four equal parts we find that 19 students were dropped for poor scholarship in the lowest quarter and only 5 from the highest quarter. In other words 4 times as many students are dropped for poor scholarship in the lowest quarter according to the Intelligence Test IV as are dropped from the highest quarter according to the same test.

Column 6 of Test IV shows that 39 students who ranked in the lowest quarter in the Intelligence Test withdrew for various reasons whereas only 13 from the highest quarter withdrew.

Test V, Physics, shows practically the same relation. Here we find that there are four times as many students dropped for poor scholarship from the lowest quarter in the Physics Test as are dropped for poor scholarship from the highest quarter of this test. See column 2, Test V. The total number of students withdrawn for various reasons from the lowest quarter of Test V is 45 whereas only 11 students from the highest quarter of the Physics Test withdrew during the first three months.

Test VI, Technical Information Test, shows again the same general relation. Seventeen students in the lowest quarter according to the General Technical Information Test were dropped for poor scholarship whereas there were only 5 from the highest quarter of this test who were dropped for poor scholarship. The other parts of the table are self-explanatory.

I wish to call your attention especially to the last table summarizing the results according to the mid percentiles of all tests. The mid percentile is the combined rank given to each student and is based on all six of these tests. The whole class is divided into four equal groups on the basis of all these tests. Inspection of this table shows that of the 44 *students who were dropped for poor scholarship and for whom we have complete records in all six tests, 24 were in the lowest quarter of the class according to the average of the six tests. Only 2 students were in the highest quarter according to the same criterion.* Eleven students from the lowest quarter were transferred to other departments whereas only 1 student from the highest quarter was transferred. Among the students withdrawn for reasons other than scholarship 19 were in the lowest quarter, whereas only 5 were in the highest quarter.

If we divide the class into quarters on the basis of the average on all these six tests there are 6 times as many students withdrawn for various reasons from the lowest quarter in the tests as in the highest quarter of the tests. The frequencies are respectively 54 and 8.

While this report is based only on the first three months of the year the results are so insistent and uniform with all of the tests and with the several criteria that there is little doubt about the diagnostic value of these tests as criteria for admission.

A similar analysis is being made for each of the forty-eight participating engineering colleges and a summary of these reports will be presented at the June meeting of the Society.

L. L. THURSTON, *Chairman.*

DEPT. OF PSYCHOLOGY,
CARNEGIE INSTITUTE OF TECHNOLOGY,
PITTSBURGH, PENNNA.

EDITORIALS.

Spirit of Coöperation.—Coöperation is essentially an engineering term since only by coöperation can engineers accomplish results. Engineering teachers are using this means more than ever. The keynote of the forthcoming meeting of this Society is Coöperation. There is to be held in Washington shortly, a conference of a large number of national and local engineering societies, where an attempt will be made to coordinate these societies so that they may coöperate with each other in promoting the welfare of the societies and the individuals which compose them.

Coöperation of the engineering schools with the industries is now well established. Dean Herman Schneider, the originator of the coöperative idea in engineering education, sees his policy being adopted by new institutions almost every day. Although the form may differ from his, the spirit underlying them is the same. We see the engineer coöperating with the economist in establishing better courses for the training of men in the matters of highway transportation and construction. The conference representing these interests called by Commissioner Claxton of the Bureau of Education, was a distinct advance and showed clearly the need of closer coöperation along these lines.

The 1920 Meeting.—The program for the 1920 meeting is nearly completed. Especial consideration has been given to the social features which have been outlined in a folder to be mailed to all members of the Society. The papers to be presented are on timely topics and by noted educators. In all ways it seems that it should be one of the best and largest meetings of this Society.

One of the special features of this meeting is the reports of committees. The committees have now been in operation for some years; they have been continued under the general supervision of the Committee on Committees and a summary of their work shows a distinct advance in all branches of engineering education. Discussion and a round table will form additional established features.

ARTHUR M. GREENE, JR.

BULLETIN

OF THE

Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee:

Arthur M. Greene, Jr., John F. Hayford, F. L. Bishop, *Editor.*

Address all communications to the Editor, University of Pittsburgh, Pittsburgh, Pa.

Vol. X Lancaster, Pa., June, 1920 No. 10

TABLE OF CONTENTS.

Arthur M. Greene, Jr. 426
Report of Committee No. 13, Mechanics and Hydraulics 427
Report of Committee No. 14, Economics 434
Teaching Elementary Economics to Engineering Students. William M. Duffus 441
Report of Committee No. 15, Civil Engineering 444
The Effect of Railway Conditions on Civil Engineering Curricula. C. C. Williams 447
Preliminary Report of Committee No. 18, Mining Engineering 455
A Coöperative Course in Electrical Engineering Conducted by Massachusetts Institute of Technology, and General Electric Company. W. H. Timbie 459
Conference between Representatives of Industry and Education S. P. Capen 477
Editorial 480
Book Reviews 481
College Notes 483

ARTHUR M. GREENE, JR., PRESIDENT, THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, 1919–1920.

President Arthur M. Greene, Jr., B.S., M.E., D.Sc., has been closely associated with the development of engineering education in the United States.

Born in Philadelphia, in 1872, he was educated at the Manual Training School, from which he was graduated in 1889, and at the University of Pennsylvania, from which he received the degrees of B.S. and M.E. in 1893 and 1894. Since then he has made himself familiar with European methods.

As an educator he has had a wide experience in various institutions differing in character and equipment. After directing the apprentice school of the Franklin Sugar Refinery for two years, he became instructor at the Drexel Institute in 1894. Returning to his *alma mater* in 1895, he remained in Philadelphia until 1902, when he was appointed professor of mechanical engineering in the University of Missouri. While junior dean of the School of Engineering, he was called to the Rensselaer Polytechnic Institute, in 1907, to organize the Sage School of Mechanical Engineering. Since then he has devoted himself untiringly to the tasks of his position.

In spite of this fact he has found opportunity to supplement his well-known "Elements of Steam Engineering" (with H. W. Spangler and S. M. Marshall) by valuable books on pumping machinery, heating and ventilation, heat engineering, and refrigeration.

As a member of the great scientific associations of America, he has also contributed materially to the advancement of his profession. In the Engineering Council and the Committee of Technical Societies especially he has helped to solve many problems resulting from the War. Of the Society for the Promotion of Engineering Education he has always been a loyal supporter.

REPORT OF COMMITTEE NO. 13, MECHANICS AND HYDRAULICS.

CORRELATION OF COURSES.

BY O. H. BASQUIN,

Northwestern University, Evanston, Illinois.

On May 3 and 4, 1920, a conference was had at Iowa City, Iowa, between Professor Stewart, chairman of the Committee on Physics, and Professor Basquin, chairman of the Committee on Mechanics and Hydraulics.

The topic of discussion was Correlation of Courses, particularly Correlation of the Mechanics Portion of General Physics and the subsequent course in Mechanics, and still more particularly whether the proposed coöperation of the two committees in making a combined syllabus, table of contents or dictionary, is appropriate and practical.

These notes are intended to record briefly some of the views of the chairman of the Committee on Mechanics and Hydraulics.

Two courses of instruction may be said to be correlated if each instructor understands the aim of the other and if he so plans his instruction as to accommodate the aim of the other instructor as well as his own.

Lack of correlation appears to be a natural result of specialization and of the division of the forces of instruction into separate departments according to topics of specialization. In specializing one narrows his point of view to his own topics; his judgment becomes excellent on these topics but it may be poor on others. Instructors in allied departments naturally develop different points of view; they take pride in developing superior points of view and they naturally plan their instruction to suit the points of view of their own departments. Thus arises a lack of correlation.

In a comparatively young institution the lack of correlation is likely to be less marked. The number of departments is smaller; specialization has not become so marked; the small number of instructors gives each a better opportunity to learn the views of others, and it is possible for each instructor to see that the success of the institution depends more upon coöperation than upon brilliant teaching in one topic that may not fit into the general plan.

The lack of correlation is therefore looked upon as the natural result of the common plan of organizing highly specialized instructors into separate departments. Assuming that the lack of correlation exists, how may this lack be overcome? How may correlation be introduced?

There seems to be a tendency in some institutions to demand that engineering students shall receive their instruction from engineering instructors, men of engineering training if not of engineering experience. A few years ago, the students of medical schools received practically all their instruction from medical instructors; this is now in process of change to a scheme whereby liberal arts instruction is required of such students before entering medical schools. It is not evident that engineering students can afford to miss the liberalizing influence that may come from contact with instructors who are not engineers; it is not believed that this plan for the introduction of correlation is of general application.

Further, it is not believed that a suggestion that instructors should be less highly specialized or that any radical change should be made in their organization into departments would be received with favor by any considerable number of institutions. The present arrangements correspond to some extent to modern methods of manufacture wherein distinct processes are conducted by specialists in distinct departments.

The method of manufacture appears to differ from the college organization in that the material operated upon is much more tangible than that upon which instructors work;

inappropriate treatment of this material is thus easily detected in manufacturing whereas it is scarcely evident in education and its result may be attributed to the wrong cause. The differences pointed out naturally lead to closer coöperation between departments in manufacturing than in education; and in manufacturing that differences of opinion between departments leads to a prompt and effective decision by the administration: differences of opinion in manufacturing are not allowed to interfere with consistent processes.

In college organization the different departments in one college are supposed to be bound together by the dean of that college; it is his business to see that the departments work harmoniously; that their instruction be correlated. The dean's authority may not extend beyond his own college. If correlation is to be established between two departments in different colleges, it seems necessary, according to the rules, to enlist the influence of the deans of both these colleges in favor of such correlation, or to carry the question to the president of the institution. This is an awkward process for the purpose, to say the least. But since these officials represent the correlating influences in the organization, I think it essential that they realize that effective correlation can become general only through their action in its favor.

If the instructors in two courses desire to establish correlation in their work, what is to prevent their doing it? The conditions for correlation are given in the fourth paragraph of these notes. The instructors are on the same campus; they meet frequently; a few conferences on the subject will make clear to each instructor what the general aim of the other is; an exchange of textbooks with marks at important parts will lead to a thorough understanding. Given the desire to introduce correlation, I see no considerable obstacle to its effective and prompt introduction. The one lack is the *desire;* the desire on the part of *both* instructors. To introduce correlation, the first thing that is to be supplied is the desire to do it. I think that this will not arise in the minds of both men spontaneously and simultaneously. This desire must come from another source. It must come from the correlating official of the institution. Each instructor must be told by his own dean that correlation must be introduced; that the dean does not care how differences of opinion are settled between the departments, but that consistent instruction must be introduced without delay.

Professor Mann's Report on Engineering Education contains an interesting account (page 30) of the means used at University of Cincinnati to develop "a very effective coördination of effort among the several departments." It is there stated that similar efforts are being tried at Sheffield Scientific School and at Stevens Institute.

The course in General Physics is commonly given to engineering students in the sophomore year; about 30 per cent. of the time for this course is devoted to the study of mechanics. Mechanics is an essential part of physics because other parts of physics are not considered as explained satisfactorily until they are solved in terms of mechanics. This study of mechanics covers the fundamental principles, it commonly embraces experimental lectures done before large classes, some individual laboratory work, recitations on a text, and the solution of some problems. This work is conducted, in general, under the direction of the physics department.

Instruction in mechanics is continued in a separate course and quite commonly under the direction of another department. In this further work the main object is to give the student a working knowledge of the subject whose fundamental principles have been studied already. Comparatively few new principles are taught the student in this second course, but many applications are made. It is customary to use a different text from the one used in Physics and in this text the subject is treated as a whole, *de novo;* the principles are again explained (perhaps using more mathematics and a somewhat more advanced view) instead of referring the student to his former text.

The teachers in this mechanics course may be young engineers with a couple of years of practical experience; they may not know the points of view of the physics instructors in that institution and they may care less; they may have found that certain points of view in mechanics have been essential in their experience in practice and they are determined to make these points clear to their students. This mechanics course differs from the physics work in that subject, in point of view and in method of instruction—the solution of numerous problems of a practical nature.

In January, 1917, the Physics Committee made a report to the Committee on Mechanics, in part, as follows:

"The Committee on Physics very much regrets the general lack of coöperation between the two courses in mechanics . . . ."

"It realizes that this lack of coöperation is due to the lack of knowledge (on the part of the instructors in physics) of succeeding engineering courses and of actual engineering problems, to the lack of knowledge (on the part of the instructors in mechanics) of the material studied in the course in physics, to the apparent lack of knowledge on the part of the student in passing from one course to the other, and to the lack of recognition of the necessity of repeated reviewing if the student actually is to acquire a *working knowledge* of mechanics."

"It realizes that coöperation in the preparation of a syllabus on *mechanics* is highly desirable as a method of influencing the coöperation which should exist between the two courses."

The report closed with a recommended plan for the preparation of the joint syllabus. The former Committee on Mechanics approved the undertaking. In December, 1917, the Committee on Physics presented to the Committee on Mechanics its portion of the proposed joint syllabus on Mechanics; and the approved plan provided that the Committee on Mechanics would furnish additional material indicative of the work of the second course in mechanics. This material was not furnished promptly and the Committee on Mechanics was reorganized the following June. The following December the matter of the joint syllabus was brought to the attention of the present Committee on Mechanics and Hydraulics. This committee had other work laid out for last year. Its position regarding the proposed syllabus has been unsatisfactory; apparently its members looked upon it as work that ought to be done out of courtesy to the Physics Committee and because the preceding Committee on Mechanics had approved the undertaking. However, no member showed enthusiasm and all appeared to be busy with duties that seemed more important. The matter was brought to a head by the request by Chairman Stewart for the conference referred to at the beginning of these notes.

The writer does not believe that the preparation of the proposed syllabus would have any material influence in bringing about the desired correlation of courses. Correlation in any one institution should be made by the adjustment of courses to one another as they are actually given in that institution, and not by the adjustment to some proposed standard that does not fit the condition that are present in any one institution. The proposed syllabus does not supply the motive for correlation in any one institution, whereas the writer believes that the motive for correlation is the one essential requirement for its establishment. The Physics portion of this proposed syllabus has been in existence for over two years and in the hands of men in mechanics; I have not learned that any mechanics course has been correlated to the Physics portion of the syllabus, whereas it seems to me that this would have happened in some institution and that such would have been reported if this material contained the key to the solution. Correlation of these two courses has not taken place at the State University of Iowa, where this proposal appears to have originated. If this matter were of compelling influence, it seems to me that it ought to have shown some effect at its source before this date.

The writer believes that the subject of correlation of courses is worthy of the attention of the Society. He believes that a campaign should be organized for the purpose of calling attention to the importance of the subject and to the necessity of securing the assistance of the proper officials to provide the motive. He thinks that papers should be published upon the attempts that have been made to secure correlation in various institutions with the results obtained, and that definite institutions be approached for the purpose of having experiments in correlation attempted for the good of the institution and for the information of the Society in attempting to develop this work.

REPORT OF COMMITTEE 14, ECONOMICS.

The Committee was assigned no specific work by the Society and has no definite recommendations to make, but desires to submit as information certain observations concerning the teaching of economics to engineering students.

These observations are not intended to be recommendations as to methods of teaching, for teachers of economics have their own methods; they are rather meant to indicate the results which in an engineer's judgment, may be most beneficial.

POINT OF VIEW IN TEACHING ECONOMICS TO ENGINEERING STUDENTS.

In this connection, the following statements of opinion are offered by the Committee:

1. The introductory course of three credit hours as recommended in the 1918 report, should consist essentially of the elements of economics, and be of such a content that it might satisfactorily serve as a basis for further study in advanced courses.

2. In the adjustment of time given to the major divisions of the subject, primary emphasis should be placed on Production.

3. Anything in the nature of *applied economics* as related to engineering, should be administered through the regular engineering departments just as the applied physical sciences are administered.

In support of this opinion, attention may be called to the fact that most textbooks as well as most professors of economics at present are chiefly or primarily concerned with the *distribution* of the nation's wealth and the products of industry rather than with the production of this wealth, and therefore, they stress the former phase of economics above the others. Exchange and commerce and the agencies thereof probably take second place in their estimation and consumption with the consideration of the nature of human wants and the elements of value assigned to third place, leaving production to receive the least attention of the four major divisions of the subject of economics. This is not their relative order of importance as they pertain to the profession of engineering. The engineer is more concerned professionally with production of the foods than he is with the equitableness of their distribution, his interests in the latter being that of any citizen. He is interested, therefore, in the economic forces which stimulate or retard production. Are personal initiative and group efficiency promoted by private control of the sources of production rather than by government control to the end that production is increased and made more efficient? What taxes are purely fiscal and what are regulatory and do some forms of taxes unduly retard production? Is output restricted and diminished by certain laws intended to regulate industry? What effect do adequate facilities for commerce have on production? Do combination of capital on the one hand and the unionization of labor on the other affect production? Do high wages with better standards of living increase production over low wage conditions? This sort of questions illustrates the professional viewpoint of the engineer with regard to economic questions. For example, the engineer professionally is primarily interested in wages as they affect production through their influence on workmen's efficiency and otherwise rather than in the general social problem as to whether they represent the just share of the products of industry that should go to labor. In the latter, he is interested as a worker himself and as a citizen, but the former phase bears on his professional activity. For this reason it is less important for the engineering student to study at great length the various economic factors that determine labor's return than it is to know the agencies which under existing conditions actually fix wages. That is, it is less important for him to follow through the arguments of those on the one hand who believe that labor's share of the products of industry (wages) is determined by "marginal utility'' or ''marginal productivity'' of labor and of those on the other hand who contend that the 'living wage'' theory as advanced by Marx, Ricardo and Smith is the determining factor, than it is for him to know that wages are actually determined in any industry by the facilities for bargaining between employees. The engineer is interested primarily in profit sharing, industrial partnership, etc., in so far as these devices may affect labor turnover, labor efficiency and ultimately, on the cost and quantity of production. In other words, the Committee feels that valuable time may be unwisely spent in classes of engineering students with comparatively immature judgment in a discussion, as the primary basis of a course in economics, of many of the advanced socialistic notions of distribution rather than in the consideration of the fairly well-established principles of productive industry and of commerce.

Attention should be called also to a possible danger that may arise in leaving an engineering student with only a brief outline or survey of economic thought which must necessarily be rather superficial, unless such survey has been skillfully administered. This student is not, generally to have the benefit of further formal studies in economics, hence, the instruction should be made as pointed and definite as possible, and loose ends of ideas and concepts should be caught up and such concepts cleared and chastened perhaps more systematically and rigorously than in the case of liberal arts students who intend to delve more deeply into the philosophy of economics. Unless this is done, inaccurate and muddled thinking may be the result of the course instead of clear cut logic that is so much desired. Economics deals largely with general averages, and the student with a smattering of economic factors may talk glibly of glittering generalities, about ''movements,'' ''trends,'' ''tendencies,'' ''waves,'' ''tides,'' ''streams,'' ''currents,'' ''drifts,'' etc., and yet may mistake a patch on a man's trousers for a ''wave of economy.'' Therefore, accuracy of observation, clear and direct thinking, and discerning judgment in analysis should be striven for in instruction, with an effort to separate the relevant from the irrelevant, in considering any particular question, rather than to arrive at certain preconceived conclusions of more or less dogmatic character, which may after all, be more dependent upon the professor's experience and training than upon an unbiased survey of facts. Most questions of political and social organization, after being brought to the attention of the class and having their significance indicated, instead of being "settled" by the teacher, would best be left to the further reading and observation of the student with the mental road left open for each to arrive at his own final conclusions.

IMPROVED PSYCHOLOGY IN TEACHING ECONOMICS.

That a good deal of time has not been well spent in the teaching of economics in attempting to project modern motives and wants back into primitive conditions of social organization is doubtless a fact. A consideration of modern motives, wants, processes and methods together is certainly more rational than to attempt to draw conclusions from the application of modern motives to primitive methods, because the motives that actuate men change with the development of social organization. Whereas a savage was actuated almost solely by elemental desires, the modern man is actuated by a complexity of wants, both natural and artificial, arising from the complex means of supplying and satisfying them; hence, to attempt to arrive at safe conclusions applicable to modern society by projecting present day motives back to the conditions of savages swapping nuts for fish, building a wigwam, making clothes of skins and bark, or of Cruso's relation to his man Friday, may be agreeable mental diversion, but is likely to be barren of usable results applicable to existing conditions.

Happily this sort of teaching of economics does not prevail to the extent that it once did, and both texts and professors devote their discussions more to actual conditions of the present industrial and social world, and attempt to connect modern complex wants and elements of value to the existing complex modes of supplying them, and to recognize, for example, the function of business ability and of organization as applied to quantity production as distinguished from the crude coöperation of a few members of a savage tribe.

The average engineering student is not familiar with business methods and the agencies and instrumentalities for conducting the economic and industrial affairs in the modern world and the instructor should take advantage of every opportunity to impart instruction along this line by using as illustrative material definite and accurate information concerning commercial processes instead of framing hypothetical and unreal situations as they may occur to him at the moment. It is true that to teach a class in this manner will require special effort on the part of the instructor even though he may be able to discuss generalities from his knowledge of the subject. The chief cause of the lack of interest on the part of engineering students is due largely to the pointless instruction of instructors who lecture out of their inner consciousness and general knowledge of the subject rather than put forth the effort to prepare specifically for this elementary instruction.

PRESENT STATUS OF COURSES IN ECONOMICS.

Two years ago, this Committee recommended that a three semester hour course in general economics be required of all engineering students, and submitted a tabular statement of the prescribed courses in economics at various institutions at that time. A revised study of conditions indicates that a few schools not requiring economics then have since introduced courses and that apparently none have reduced the amount of time devoted to the subject. Some have introduced courses in what may be termed *applied economics,* such as management, administration, costs and ratemaking, valuation, etc., taught by members of the engineering faculty. The opinion of the Committee, based on the observation of only a few cases, is that these latter courses, where taught by a professor of engineering of broad professional experience, are of much value.

As indicated in the 1918 report of this Committee, some engineers and writers appear to confuse *economy* or *economics of design, construction and operation,* which takes into consideration the factors affecting the cost and financing of engineering projects, with *economics* or *political economy* as the term is employed by collegiate faculties. There is a danger of rendering the term *economics threadbare* and meaningless by its promiscuous use, and this resulting vagueness of the term has apparently led some to suppose that collegiate departments include many subjects in their curricula which as a matter of fact they are not equipped to teach nor do they make any attempt to do so.

COMBINED COURSES OF COMMERCE AND ENGINEERING.

Somewhat over a year ago, certain conferences were held under the direction of the Bureau of Education to foster the development of courses involving a combination of technical subjects with economics as preparation for managerial positions. A few schools have instituted such courses, as related in last year's report, and this list has been slightly increased during the year. All these courses, except perhaps that at Carnegie Institute of Technology, are fundamentally courses in engineering with economics and similar subjects substituted for some of the more highly specialized technical subjects. In one instance, at least, the courses in economics are added as a fifth year to the regular engineering curricula, and in another, the combined course is of six years duration coördinate with the other technical courses at the same institution.

While the Committee is not prepared to offer an opinion as to the feasibility of such courses generally, it appears that the interest, as indicated by the number of students enrolled in them, is greater in the populous manufacturing and commercial centers than it is in the mid-west institutions. Massachusetts Institute of Technology, for instance, reports a growing enrollment in its course in Engineering Administration, while two mid-west universities have practically no demand for similar courses. This is the situation that would naturally be expected from the circumstances.

REPORT OF COMMITTEE NO. 14.

The Committee believes that the application of the term "Commercial Engineering," as proposed by the Bureau of Education to courses in schools of commerce, which include a small amount of informational study in engineering methods and processes, is undesirable, because "engineering" has through the past century taken on a fairly well defined meaning, and to apply it loosely to the specific operations and procedure of commerce, to salesmanship, of miscellaneous goods, to advertising, accounting, etc., is but rendering the term more meaningless as signifying a profession.

J. W. Dietz,
A. B. McDaniel,
E. B. Paine,
P. F. Walker,
C. C. Williams, *Chairman,*
Committee.

The Committee begs to submit as an Appendix to the above report, the following brief paper on "Teaching Elementary Economics to Engineering Students" by William M. Duffus, associate professor of economics at the University of Kansas, who has taught the economics classes for engineering students at that institution during the past year, and who has given considerable thought to the character of instruction best adapted to the conditions.

TEACHING ELEMENTARY ECONOMICS TO ENGINEERING STUDENTS.

BY WILLIAM M. DUFFUS,

Associate Professor of Economics, University of Kansas.

In compliance with the Committee's request the writer is glad to state some of the opinions which he has formed concerning the problem of teaching economics to students of engineering. However, he wishes it understood that his opinions are the result of but one year's experience with the problem and that some of them are tentative conclusions rather than expressions of final judgment.

First of all, it seems to the writer, the committee is to be congratulated upon its discernment in emphasizing the necessity for thorough drill in what are generally accepted as the fundamental principles of economics. The engineer, if he is to rise to his opportunities for personal advancement and for service to others, needs to have a good grasp of these principles and a reasonably accurate knowledge of the nature and problems of modern economic institutions. He can best get these aids to efficiency as the rest of us can best get them—by the study of economic forces and economic institutions as they are found in the world at large. It is no more possible to *divide* the *principles* of economic science successfully into economics for business men, economics for farmers, economics for engineers and economics for apothecaries than it is to divide the principles of the physical sciences in the same way.

Although all students studying economics need to study the same fundamental economic principles, whatever the professions for which they may be preparing, they do not all need to approach the subject in the same way. In fact there are distinct advantages in using methods of approach which differ more or less in accordance with the experience, maturity and interests of the student. The maintenance of courses exclusively for students of engineering would seem to be an aid to good instruction.

It must also be admitted that *after* the student acquires a knowledge of the fundamental principles of economics he may reasonably be permitted, within pretty broad limits, to apply that knowledge and make further inquiries in the fields of economic activity in which he is professionally most interested, even though he has to neglect other fields. To illustrate, the student of agriculture may reasonably be given special instruction in rural credits and the marketing of farm products; the student of engineering may just as reasonably be given special instruction in the problems of industrial relations, the regulation of railroads and public utilities, and the organization and financing of business enterprises. But, it may be remarked parenthetically, there will be little opportunity for any instruction in these or in certain other very important phases of economics as long as the present limitation of the time given to economics to a maximum of three hours per week for one semester prevails. The writer earnestly believes that the extension of the time for the course from three to five or six hours would more than double the value of the course.

Taking the situation as it stands, the use of the class discussion method of instruction, with assigned readings in one textbook and in one or more books of readings and frequent short written quizzes, will probably give the best results. There should be at least one section for every 35 or 40 students. The instructor, especially at the outset of his work, should make an especial effort to explain specifically how and why a knowledge of economics is essential to the engineer and should point out from time to time as he develops his subject the importance of the different phases of it to the engineer. He should be as direct and concise as possible in his own share in the class discussion and should use concrete and up-to-date illustrative material. He should avoid the elaboration of finespun theories in matters of controversy in so far as it can be done without sacrificing scientific accuracy. For it must be remembered that the student of engineering is training himself for a very practical life and not for a life as a speculative philosopher.

It is probable that a textbook especially designed to meet the needs of students of engineering would be a material aid, if properly written, in the teaching of economics for engineers. Such a book should be written by an economist who has had experience in teaching engineering students and who knows something of their psychology and the difficulties which they have in grasping the subject. It should be written with the point of view of the student constantly in mind. It may be difficult, however, to induce any competent economist to undertake the task as long as the present time limitation on the work of the course remains effective.

The writer has used Ely's "Outlines of Economics" as the text this year and has assigned additional readings in Marshall, Wright and Field's "Materials for the Study of Elementary Economics." Such collections of illustrative material as are found in Marshall's "Readings in Industrial Society," Hamilton's "Current Economic Problems" and some of the more specialized books of readings might well be used as additional references. The writer has found it inadvisable to depend upon any one book of readings. In fact he is among those instructors who are desirous of seeing some plan for the provision of loose-leaf, up-to-date illustrative material worked out as an experiment. In this connection readers may be interested to know that a committee of members of the American Economic Association, chosen from among instructors of elementary classes in universities and colleges, is studying the possibility of establishing such a plan.

There is a disposition among some teachers of economics to regard students of engineering as particularly hard to teach. The writer's experience does not warrant this belief. If the instructor receives proper support from the school or departments of engineering and if he approaches his subject with proper consideration for the psychology of his students and with proper enthusiasm on his own part he should be able to obtain results that will compare favorably with those obtained in teaching academic students or students preparing for commercial pursuits.

REPORT OF COMMITTEE NO. 15, CIVIL ENGINEERING.

SUBJECT: METHODS AND DETAILS OF TEACHING STRUCTURAL DESIGN.

The above subject was assigned to the Committee nearly three years ago. A progress report including three formal papers, was presented at the Evanston meeting which, with discussion, appears in the 1918 *Proceedings*. The work was continued during the following year primarily by means of discussions by Messrs. C. E. Fowler, J. A. L. Waddell, H. P. Gillette, Gustav Lindenthal, O. H. Basquin, S. C. Hollister, Edward Godfrey, and F. E. Schmitt. These were published in the April and May (1919) numbers of the BULLETIN, but not in the *Proceedings*.

A report, which was regarded by the Committee as a final one, was presented at the Baltimore meeting which, with discussions was published in the 1919 *Proceedings*.

This report contained a "Summary of Conclusions" which, by vote of the meeting was made a part of the program of the 1920 convention for discussion and possible adoption.

The Committee has given an attentive ear to the discussions and, with further study, takes the liberty to make one slight change and two additions to the Summary as presented a year ago. It therefore presents, for approval by the Society, as the principles which should be considered in planning and administering the structural courses of a curriculum in Civil Engineering:

1. The general curriculum in Civil Engineering should be fundamental in character and broad in scope.

2. The structural courses should be considered as a part of the general curriculum and not as independent courses.

3. The structural courses should be so comprehensive and

at the same time so fundamental that they will enable the student to understand the main features of the design of structures and, at the same time, serve as a basis for future specialization in college or in practice.

4. The required structural courses should include:

(*a*) Mechanics, including statics, dynamics, and mechanics of materials.

(*b*) An experimental and physical study of the usual materials of construction, including iron, steel, timber, cement and concrete.

(*c*) The theory of reinforced concrete construction with just sufficient design to illustrate and fix the principles involved.

(*d*) An analysis of stresses and deflections in framed structures from a general standpoint which may be extended, when desired, to any structure, for dead and live loads.

(*e*) The principles underlying the design of sections and of details with just sufficient work in design to illustrate and fix those principles.

(*f*) An introduction to the principles of estimating and to the procedure of producing structures.

5. Electric structural courses should be provided in accordance with the policy and the needs of the individual institution.

6. The methods employed should be such as to arouse the student's interest and be directed towards the discovery and development, by the student, of the principles involved, rather than to "teach" him certain standard theories and methods.

The slight change mentioned above consists of dropping the words "statically determinate" which preceded "structure" in 4 (*d*). The discussion has brought out the fact that in a number of required courses including those given by two members of the committee, the stress work has been extended to some statically indeterminate conditions with apparent success. The change does not necessarily recommend this procedure, but it specifically removes a recommendation that statically indeterminate work be excluded.

4 (*f*) was added to meet a demand, championed particularly by Professor McKibben at the Baltimore meeting, for giving the student an insight into the shop and managerial problems involved in producing structures and for calling attention to the need of considering estimates in connection with the structural courses unless provision has been made elsewhere in the curriculum.

5 has been added to cover the demand from certain sources for additional work. The committee feels that further requirements in structural lines, accompanied by similar ones in railroads, water supply, sewerage, etc., would defeat the purpose of a strong fundamental course, but recognizes that a certain amount of specialization may be desirable for some men at some places and that this can best be provided for through electives.

Respectfully submitted,

A. H. FULLER, *Chairman,*
W. C. HUNTINGTON,
H. T. BURT,
C. T. MORRIS,
J. HAMMOND SMITH,
Committee No. 15.

THE EFFECT OF RAILWAY CONDITIONS ON CIVIL ENGINEERING CURRICULA.

BY CLEMENT C. WILLIAMS,
Professor of Civil Engineering, University of Kansas.

In a recent number of a technical periodical appeared the rather startling statement by the head of the civil engineering department at one of our great universities that no work in railway engineering was required at that institution in the civil engineering course but that all railway work offered there was elective. The statement was all the more noteworthy because this eminent professor is a civil engineer of established reputation, who has entered the educational ranks within comparatively recent years, and therefore, is perhaps least biased in his thinking by educational tradition, and also, because he is preëminently a railroad and construction engineer. The reason given for such attitude was the lack of favorable consideration of technical graduates by the railroads in their engineering departments.

This brief discussion is not intended primarily as a comment on the action at the above mentioned institution, but the statement merely accounts to a certain extent for a taking stock of the present situation with a view to arriving at a definite policy that may be rational and justifiable in the light of existing conditions.

In years past, it will be readily enough admitted perhaps, technical schools devoted more time than was justified to the sort of railway engineering that was then taught. This situation resulted largely from a dearth of better material to constitute a civil engineering curriculum, resulting in the offering of courses in railway drawing of a rather useless sort, in stereotomy, in track maintenance including a study of details that were unintelligible to the average student, and extended practice exercises in railway location surveys. These subjects have either been eliminated altogether or have been greatly condensed and concentrated, due to the development of more suitable and essential material for study in civil engineering and due to the prevailing increased effectiveness in teaching.

However, a certain amount of railway engineering is retained in all the civil engineering curricula of the larger institutions with perhaps the exception of the university mentioned above. The retention of such courses probably results from two main reasons.

In the first place, the consensus of opinion among educators seems to be that a curriculum should not be fashioned to meet the needs of a particular type of commercial position or a circumscribed group on such positions, and that if the subjects offered have no broader application than to fulfill the requirements of a certain class of positions, they have no legitimate place in a curriculum. Regardless of the outcome of the controversy between professional pedagogists and psychologists as to whether there may be a transfer of formal discipline from one realm of mental activity to another, it has been amply demonstrated that a given mode of attack in the analysis and solution of one class of problems will aid in undertaking another group more or less similar which may be susceptible to a similar mode of treatment. The methods of railway surveys and earthwork calculations are a case in point, inasmuch as they are applicable to any construction line survey, such as railway, highway, irrigation, drainage or other canal, levee work, etc., differing chiefly in that they are the most precise of the group, and that they have been reduced to more definite and scientific procedure. The diversity of their applicability therefore would justify the retention of a certain amount of railway surveys in civil engineering curricula which aim at training for the general practice of the profession.

Studies in the economics of railway location and construction are likewise justified because the same mode of attack is applicable to highway and any other form of transportation engineering, or, for that matter, to determining the economic significance for any extensive project, and also, because the records and systematic accounting required by the Interstate Commerce Commission render railway operation and performance most readily available for scientific study and analysis. In other words, this type of training and discipline, which is fundamental and of general applicability, can be obtained more advantageously and reliably from studies in railway engineering than in other subjects.

In the second place, even a casual study of history indicates that transportation and communication have been among the most potent factors in the evolution of industry and civilization and the indications are that they will remain so, and hence, for the liberalizing to a certain extent the curriculum, a modicum of railway engineering is desirable. Obviously, in this connection, the railway engineering that is offered should be more than a study of curves and surveys. It should include an inquiry into the factors that limit the capacity of a railway, or, otherwise stated, the harmonious and consistent design of a railway as a manufacturing and commercial enterprise.

Granted then that railway engineering properly forms a part of a general civil engineering curriculum, it may seem desirable to shift the emphasis somewhat from the purely physical considerations to include a certain amount of the economic phases of railway construction, particularly in view of the changed conditions in the railway situation in this country. While there remain many physical problems of the first magnitude in the future of railway engineering, it is the writer's opinion that perhaps the most complex and important problems of the future are largely economic, although entirely within the realm of engineering. The questions are not those of pure economics, but rather of applied economics,—economics that arrives at a definite numerical answer or conclusion.

It is probably true that railway engineering as generally taught and practiced in the past was too much detached from the vitals of railway operation. A railroad is primarily a plant to manufacture and sell transportation, and railway engineering has been rather remotely connected to either of these processes. Only in the introduction of certain line and grade improvements by means of which heavier tonnage could be hauled has the engineer directly contributed to increasing the plant's capacity to manufacture transportation, and he has seldom had anything to do with increasing the sale of transportation. He has been a rear flagman, as it were, performing a necessary service, but somewhat detached from the main party. As a result, he has been prone to forget his relation to the main plant, and has done little more than—continuing the simile—give backsights when so directed.

The passage of a freight train to many a transitman on maintenance has meant only a brief interruption of his work, a wave of the hand to the engineman, and an indication perhaps of approximately the time of day. Should it stimulate his inquisitiveness and cause him to discover the answers to a number of questions, such as the following for instance, it might bring him to a realization of his relationship to the entire plant. "Is the train that interrupted the work as long as it should be for the grades over this division? Could the division points be changed so as to cause a smaller loss of transportation capacity while passing over intermediate rise and fall? Could traffic be hauled more economically if the grades were reduced? Are all the cars full? Could they be operated full with this character of traffic? Why were there empties in the train? Are empties hauled in the opposite direction also? Where did the cargoes originate? What is their destination? Is this the most economical route? Will the cars return empty or will there be a return traffic available? What could be done to tend to balance the traffic over the line? Does this freight train stand longer on sidings than necessary waiting for passenger or other trains? Should the spacing of sidings be re-adjusted to prevent such loss of time? Is enough time lost to justify an additional track, entirely or at low speed points? What proportion of the time is this rolling stock moving? Could this train be made to follow the preceding one more closely to advantage by shortening the blocks? What would be the effect on transportation costs if this train were speeded up somewhat? Which does the more damage to the track, this freight or a passenger train? How much more? etc.'' Such meditations during odd moments might bring the young engineer to a more definite appreciation of his relation to the entire railway plant organization. Indeed, unless the young engineer does enter into vital participation in the operating strategy of the railway, he is likely to find railway engineering a disappointing field of endeavor. Unless he sees more to his work than the aligning of curves, setting of construction stakes, calculation of estimates and detailing minor structures, he will succeed about as well as the structural engineer whose vision is limited to the computation of stresses and the proportioning of parts, or the hydraulic engineer whose capabilities extend only to the determination of head losses and the flow of water. The work offered in railway engineering, therefore, should lead the student to be alert to see the ultimate relationships of the tasks which he may have in hand.

As suggested above, the railway projects of the future will probably be adjusted with a nicety in respect to economic considerations that has not characterized railway engineering in the past. The problems to be solved will be largely those of construction based on a judicious analysis of statistical and economic factors. Radical changes may be expected in the needs of the railways which may give rise to numerous engineering enterprises. The railways are to be regrouped into a certain number of systems in a comprehensively planned scheme on the basis of natural and logical transportation routes, and these routes are likely to be quite different from what they have been previously. Our railways have been largely east and west lines, predicated on the assumption of the Atlantic Coast as offering the only ports of foreign shipping. This condition may be fundamentally changed in the near future to such an extent as to render the old assumption partially obsolete. Already the Panama Canal has made New

Orleans the second export city, and the opening of the Great Lakes to ocean-going vessels via the enlarged Welland Canal making Chicago and other lake cities foreign shipping ports, together with the possible improvement of the lower Mississippi, if found feasible, to admit ocean-going vessels to the middle of the country loading for foreign ports at certain river cities, will profoundly affect the basis on which these groupings are to be adjusted. Our railways will naturally be laid out on a comprehensive unified plan, the basis for which will be controlled largely by the part that America takes in the world's commerce and the arrangement of ports that will afford the most direct shipping, as well as by the conditions affecting domestic traffic.

Because of this regrouping of the railways, extensive improvements will be required in the way of multiple tracking, lines and grade improvement and terminal construction, and the design of these will be based upon an expert analysis of the transportation requirements. While it is out of the question, of course, in the class room to enter into these major problems confronting the railroads, yet many of the general principles determining their solution may be investigated and studied.

Another factor also must be considered in connection with the future railway situation, namely, the improvement of the highways and the development of highway transport, which will inevitably have a potent effect on the character of railway traffic. Unless terminal expenses can be reduced to a marked degree, local freight of small tonnage will be carried by the highways, and under any circumstances, the amount of local freight thus transported will be such as materially to affect certain operating conditions.

Owing to these developments and changes in the railway situation, therefore, the writer is of the opinion that some time that was formerly given to the study of purely physical factors might be appropriately diverted to a consideration of certain more general commercial or economic aspects of the situation. Assuredly the design of location and of terminals, two elements of prime importance in the recasting of the railways that will occur within the next few years, should receive some attention.

Engineers will be indispensable in this program, for it is incredible that an industry of the magnitude of the railways can be efficiently constructed and operated without the aid of technically trained men. Whether these men will all be on the regular staffs of the railways will largely depend upon the attitude of the railways in regard to the payment of its engineers and to the conditions of service. At the present time, the engineering staffs of the railroads are depleted and young men graduating from college are not attracted to this work—in fact are prejudiced against it—because of the unfavorable conditions that have existed in the past. Three major complaints are lodged against the railways by young engineers: (1) low pay, (2) long working hours including Sundays and holidays without extra pay, and (3) small chance for advancement, especially into administrative and executive offices. If the compensation is made commensurate with the skill and responsibility required, the hours of working placed on a basis similar to that obtaining in other industries, and an opportunity for promotion provided, capable engineers will seek permanent railway service, while on the other hand, if these conditions are not made satisfactory, the more capable men will not enter railway service, for other industries have come to appreciate the value of technically trained men and will offer more attractive opportunities, and in that event, we may expect to find the more intricate and important railway engineering done by consulting engineers of vision and capacity, while the railway staff, inevitably under such circumstances composed of mediocre men, occupied in routine maintenance. This statement is not made in depreciation, for indeed, the condition last mentioned may be in the final adjustment the logical and appropriate one. Cities, water companies, bridge companies, and other industries usually do not retain a large permanent force of high class engineers but for special problems rely on the expert consulting engineer, depending on their regular forces to attend to routine matters of operation. Already there are evidences of the development of the consultant in railway practice comparable to those in other branches of the profession. Whatever, the engineering organization that may do the work, certain it is that railways will need technical engineers, and it seems no more logical to discontinue instruction in this branch than it would be in water supplies because of the fact that water companies and cities do not generally employ regularly expert engineers. It is as reasonable to prepare men for railway work under consulting engineers as for bridge, municipal or hydraulic work under consulting engineers. Such work would be the legitimate practice of the profession.

In conclusion, it is the writer's opinion that a proper amount of railway engineering should be included in a civil engineering curriculum because of the general applicability of the training derived therefrom, although it may be desirable to shift the emphasis somewhat from the purely physical matters to include certain of the economic phases; and that whether the larger work in railway engineering is done by regular staffs or by consulting engineers makes little difference, the fact remaining that an industry of such magnitude as the railways will always either employ or retain technical engineers of superior skill and capacity.

PRELIMINARY REPORT OF COMMITTEE NO. 18, MINING ENGINEERING.

The general mining engineering profession is less specialized than any of the other engineering professions. Its own field takes in many of the others. Its growth and development have been so comprehensive that its subdivision into Mining Engineering and Metallurgical Engineering is already well advanced, although this Society still holds it under the parent name. The extraction of ores from the earth is especially mining engineering, while the treatment and reduction of ores is especially metallurgical engineering. There are a number of specialized branches of the former, such as coal mining, metal mining, hydraulic mining, etc.; and there are two well defined divisions of the latter into furnace engineering and milling engineering.

The profession in general has to do with civil, mechanical, electrical, hydraulic and chemical engineering; and in addition to the first four of these branches of engineering, it requires in its digging operations knowledge of the science of mining and of geology, and the solution of the problems of handling and controlling stupendous mass weights and movements.

The operating mining engineer will further require a knowledge of business science, and skill in organization and employment.

What then, may we enquire, is the best possible training to be given the undergraduate mining engineer in the time usually alotted, and what shall be done to bring about desired improvements?

Five different topics has been suggested for the discussion of this question, as follows:

1. The standardization of methods of teaching.

2. The improvement of the standard of instructional work.
3. The designation of essential equipments for mining, ore dressing, and metallurgical laboratories.
4. The discouragement of the further establishment of mining schools where not needed.
5. The amplification or revision of the mining section of the report of the Committee on Requirements for Graduation, published in 1904 and 1905, Vols. XII and XIII.

The first has special reference to the coördination of class room and laboratory instruction, laboratory methods, and field practice.

The second topic involves two correlative propositions: on the one hand, the improvement of instructional ability and equipment; and, on the other hand, the improvement of the quality of student. The one is largely a question of compensation and price; the other may be accomplished, perhaps, by careful selection and by reaching back with greater attention to early training. Instructors of the specialized, or applied, subjects should themselves be thoroughly trained in the fundamentals, and understand the relations between the two classes of subjects. Moreover, it would be best if the teachers of the fundamental subjects had a thorough knowledge of the applied; but this would be an impracticable requirement, especially in the large schools giving many different engineering courses.

In approaching the third topic, we may observe that to the engineer a training in capacity for calculation and anaylsis is essential, capacity for manipulation may be convenient: designing and directing are essential, expert tradesmanship is of secondary importance: a knowledge of business science may be acquired: and an understanding of humanity may be cultivated, but the capacity for it must be inborn. The difference between the trade school and the engineering school should be kept in mind. A man may be an expert miner, mill man, furnace man, or assayer, or all of these, and not be a mining engineer. However, it is usually desirable that the graduate mining engineer should be a good surveyor, or assayor, or chemist, or accountant, etc., in order that he may enter the mining business with a qualification with which he may make himself useful to his employer and incidentally earn a living. The particular line in which the undergraduate may choose to make himself useful may depend upon the branch of mining engineering he wishes to follow, or it may determine for him the branch that he shall follow: but if he is well grounded in the fundamentals, the whole field is open to him.

The essential equipments for the different laboratories are only such machinery and apparatus as illustrate and represent the operations and practices that have become standard, or illustrate some important, fundamental principle. Standard operations and practices that are susceptible to laboratory treatment, are relatively few in number: in mining, they are drilling, blasting, and supporting excavations; in assaying, they are sampling, charging, melting, and cupelling; in ore dressing, they are crushing, classifying, concentrating, and, in some cases, extracting; in metallurgy, leaching and flotation are susceptible to laboratory treatment. But, important, fundamental principles remain matters of individual opinion, and we cannot designate essential equipments for their illustration, except each for himself.

The fourth proposition may be favored on the ground that the establishment of mining schools where not needed is liable to be accompanied with insufficient equipment and support, the employment of inferior instruction, the graduation of men with inferior preparation, and the general degradation of the profession. On the other hand it may be urged that such schools, by calling attention to mining engineering education, turn many good men toward the better schools.

We shall introduce the consideration of the fifth topic by giving a summary of that part of the report pertaining to mining engineering, as follows:

	Hours.
Language	400
Mathematics	800
Physics	700
Chemistry, including assaying	800
Geology and mineralogy	700
Drawing and lettering	300
Surveying and mapping	800
Chemical and metallurgical engineering and ore dressing	700
Structural engineering, statical and mechanical, and materials of.	600
Mining engineering, principally underground	700
Mining engineering, principally underground, and including organization and management	700
Total hours	7,200

The above is designed to cover a general course for graduation in mining engineering, and the first question that arises pertains to the list of subjects; the second, to the proper distribution of time; the third, the detailed subdivision of the subjects; and the fourth, the arrangement of curricula for different specialized courses in mining engineering, such as Coal Mining Engineering, Metal Mining Engineering, etc. Specialized courses in mining engineering appear to be an actual demand of the times that should be provided.

F. W. Sperr, *Chairman.*
H. H. Stoek,
E. A. Holbrook,
J. B. Porter,
H. E. T. Haultain,
Committee.

A COÖPERATIVE COURSE IN ELECTRICAL ENGINEERING CONDUCTED BY MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND GENERAL ELECTRIC COMPANY.*

BY W. H. TIMBIE,

Associate Professor in Electrical Engineering, Massachusetts Institute of Technology.

The educational scheme known as the Coöperative Plan is not new in itself. That there are distinct advantages in acquiring theory and practice at the same time has long been recognized, and several technical schools, notably those abroad, have been operating on this plan for several years. The College of Science and Arts in Glasgow, the Faraday House in London, and the University of Copenhagen in Denmark, are well-known examples. In this country we are indebted to Dr. Herman Schneider for inaugurating the coöperative work at the University of Cincinnati. Courses similar in detail have been operated by the University of Pittsburgh and by Marquette University at Milwaukee. The only excuse we have for coming before you with the Technology Coöperative Course in Electrical Engineering is that it differs in several important respects from the coöperative schemes of other institutions. It is these differences that I wish to call to your attention, and explain reasons for their existence.

It should be said at the very beginning that the coöperative course herein described was not planned for the purpose of training electrical engineers in every field; and it does not take the place of our old and well-established electrical engineering course, but is an addition thereto for a collateral object. In fact, at present its scope is rather limited. It is avowedly an effort at intensive education and training of electrical engineers to meet a specific demand. Perhaps the easiest way to describe just the field that these men are being trained for is to consider for a moment the various fields in which electrical engineers are needed. We can roughly divide electrical engineers into three rather arbitrary divisions:

---

* To be presented at the 28th annual meeting, June 29 to July 2.

First, the consulting engineer, who is usually attached to one or more electrical companies or users of electrical power, to advise them in cases where expert electrical knowledge is needed.

Second, the administrative engineer who may have a large financial responsibility in addition to his duties as electrical engineer. Such a man would be called upon to take the responsibility for the electrical end of any project in the development and utilization of electrical power. In fact, both of these first two types are more closely connected with the development and administration of projects for using electric power than with the manufacture of the machinery involved in such projects, and are in fields which are of themselves of tremendous magnitude, breadth and importance.

In the *Third* division, then, belongs the engineer who is intimately connected with the design and manufacture of electric machinery and accessories. He superintends the design and manufacture of most of the apparatus used by the other two types. His qualifications call for an intimate knowledge of the best manufacturing processes and a thorough training in modern research methods—to which must often be added the ability for creative design. This is the engineer that the Massachusetts Institute of Technology is endeavoring to train by means of its coöperative course in electrical engineering.

And he is not confined to manufacturing electrical appliances. This is the engineer that will be needed in ever-increasing numbers as the country turns more and more to the manufacturing industries in order to sustain itself. The alarming rate at which the natural resources of the country are being depleted has made it imperative that the country at large eventually rely almost entirely upon its manufactures. No longer can we depend upon our exports of raw materials to pay our bills. These raw materials—lumber, ores, and oils—must be manufactured into finished products if the living expenses of the population are to be met. Our water powers must be utilized and new methods of using our oil and coal more efficiently must be devised. In all this work, manufacturing engineers of the highest type are needed, and become the most valuable asset of the country. It is these men who in the last analysis must direct the operation of the nation's industries. For our industries cannot compete with those of other countries unless they are conducted by men who have large vision, intimate knowledge of manufacturing details, and a thorough training in science and scientific methods. Manufacturing must be conducted on a sound financial basis, which means that processes of production must be so managed that the total cost of the finished article will be low enough to compete with the products of foreign factories. For this task the services of an engineer who has a thorough knowledge of manufacturing processes are invaluable and his duties multifarious. He must not only be familiar with the best methods of production, but he must thoroughly understand scientific research, in order that he may take advantage of new discoveries and continually better his methods of production. This cannot be stated better than in the words of the Governor of Massachusetts, Calvin Coolidge. "Our prosperity comes from our industry and our industry cannot flourish unless it is directed with the highest intelligence. Far more in the future than in the past will this intelligence call for sound training in science and in its innumerable applications to industry."

The General Electric Comapny, as well as other large manufacturing concerns, for years have felt the lack of this type of engineer. They have endeavored to train up in their own organization a corps of men sufficient to fill the ever increasing number of positions of this kind. Now the General Electric Company employs 65,000 men and yearly puts out a manufactured product whose market value is over $250,000,000. From these figures you can gain some idea of the quota of manufacturing engineers needed by this one company. The normal growth of the company averages 18 per cent per year. To take care of this increased business there is needed an increased force of engineers. When we add to this number the inevitable replacements necessary each year, some idea is gained of how great is the task of training a sufficiently large corps of these high grade engineers. Every large manufacturing concern admits its inability to obtain a sufficient number of these men to meet the yearly demand, especially as the graduate from the usual mechanical engineering and electrical engineering course requires much additional training and experience before he is a good manufacturing engineer.

The coöperative electrical engineering course at the Massachusetts Institute of Technology is an attempt on the part of the General Electric Company and the institute to solve this problem. In this plan the students have the advantage which the institute offers in the way of theoretical and technical training combined with the enormous resources which the General Electric Company offers for practical experience in the manufacture of electric appliances. Most of the theoretical training is given at Cambridge. The greater part of the practical training is given at Lynn, a distance of about ten miles from Cambridge. The course is supervised by a joint committee of the institute and the company. A professor of the institute is associated with an officer of the company in the duty of supervising the progress of the students while at the Lynn Works.

The course covers a period of five years, the first two years being identical with the regular course in electrical engineering at the institute; the last three years being divided between the instruction in theory at the institute and training in manufacturing methods at the General Electric Company. The coöperative features thus occupy only the last three years, starting in the summer after the sophomore year.

While at the works the students are given a fixed payment per week as employees of the company, which payment is the same whatever department of the works may be the one to which the student is assigned. At the completion of the five year course the students receive the Master of Science degree and the Bachelor of Science degree their graduation taking place at the regular commencement time at the institute.

The first class was limited to thirty members. The class which enters July 6 this year will consist of sixty. The size of future classes may be still greater.

The first week in July, the entire class who have just completed their sophomore year are sent to the General Electric Company's works at Lynn and placed in various shops. Here they remain for thirteen weeks. At the opening of the fall term at the institute, one half of the students return to Cambridge and pursue for one term what is practically the regular course in electrical engineering. At the end of this term they have a vacation of two weeks and then go back to the works of the General Electric Company for further experience. The other group now returns to the institute for further theoretical instruction. This schedule is carried out for three years, each group spending alternately thirteen weeks at the General Electric Company's plant and eleven weeks at the institute. The vacation of two weeks given the students at the end of their period at the institute divides the year into four equal periods of thirteen weeks each. The last period of the fifth year, is spent by both groups at the institute so that the two groups graduate together at the regular commencement time. Yet each group has spent an equal number of weeks in theoretical instruction and practical application.

Now as to the points of difference between this and other coöperative courses. No doubt, on the surface, the most striking feature is in the length of the periods. This, however, is perhaps the least important difference. It was endeavored to arrange the details of the course so that they would fit into a system of education which the founders believe is basic. This system combines the rudiments of Spencer's theory of education with the central idea of Josiah Royce's. It is an endeavor to develop all the desirable sides of a student's mind, character, and body, and at the same time inculcate in him the spirit of loyalty to his life's work. The course had to be planned so that these several activities would be carried on uninterruptedly throughout those periods which the student spends at the institute and at the works. You will note that in the scheme as outlined, the following activities are carried on continuously throughout the course: Instruction is given in theory, classes are conducted in some humanistic study, time is given and facilities provided for collaterial reading, and arrangements are made for physical exercise and recreation. The change therefore at the end of each period does not mean so much a change in occupation as a change in emphasis and the length of the periods thus becomes a rather unimportant detail.

The period of thirteen weeks at the shop and eleven weeks at the institute followed by a vacation of two weeks, was decided upon for the following reasons. It was believed that the period at the works should be long enough for the student to spend in each department an uninterrupted period of sufficient length to become thoroughly familiar with the men, methods, materials and spirit of that department. In some departments the time required for this amount is practically three months, and in others it may be as low as one month. The thirteen weeks' period will therefore meet the conditions required for those departments in which he must spend the longest time and does not prevent him from dividing his time among two or three departments in case he is able to master the details in a shorter time. The same is true concerning the length of the period at the institute. The shortest course at Technology is ten weeks in length, and all longer courses are some multiple of ten weeks. The student is thus able to pursue his studies at the institute in units of standard length. Furthermore, the fact was not lost sight of that at each change some time was lost by the student in getting started on the new work. Therefore, the periods were made of sufficient length to keep the number of changes as low as practicable. Finally it was hoped that the length of the period had been so chosen that the sojourn at the works would come as a sort of mental relief and recreation from the term's work at the institute. In fact it was hoped that toward the end of the term's work the student would begin to look forward to the change as a welcome break in the routine of study, and on the other hand, that the length of the period at the works would be sufficient to quicken his desire and appetite for further mental concentration and study. The fact is, the thirteen weeks' period has proven that these results have been accomplished. But whether or not a somewhat shorter or longer period would produce the same results has not been experimented with, because the period of thirteen weeks fits into the institute calender in such a way that the periods spent at the institute are practicably coincident with the regular institute terms. So much for the length of period.

The real vital difference, it seems to me, between this course and other coöperative courses conducted in this country, is the fact that the coöperating company recognizes that for three years these students are placed in its plant for the particular purpose of being educated and trained as electrical engineers of a particularly high grade. There is not the slightest effort or inclination on the part of this company to use these students for the purpose of getting out greater immediate production. It is clearly understood that these students are in the shops and offices to learn, and to learn thoroughly, manufacturing methods, and the best relations of labor, mechanism, and materials in high-grade production. Because he can best obtain this knowledge by actually doing the work himself, and because the skill which he attains in any process is the only fair indication of his knowledge of that process, the student is put on the company's pay roll and becomes part of its organization. The length of time spent in each department is regulated not by the needs of that Department but by the value of the experience to the student. As soon as it deemed that he has all the knowledge of the details of the department that a manufacturing engineer should have, he is immediately changed to another department. This change is made upon consultation between the foreman of the shop, and the officer of the company, and the professor of the institute, who are associated in conducting the course.

It is not to be inferred from this statement that the coöperative students do not work as earnestly and as consistently as the other men in the various departments. The coöperative students are graded on the amount and the quality of the work which they do in the various shops, and as strong inducements to do good work are put before them as are put before the regular workmen. The only difference between their work and that of the other employees is that the students' work is so laid out that they receive a maximum amount of experience from each job and they are kept at it just long enough to enable them to become fairly proficient in the necessary operations. In this way the minimum amount of time is spent in learning the details of manufacture in the different shops, testing departments, drafting rooms and engineering offices.

This spirit on the part of the coöperating company, it seems to me, is the fundamental contribution which this coöperative scheme offers to engineering education. All the other points of difference between this and other coöperative courses are made possible and have their origin in this spirit of the General Electric Company, which, we believe, is the true coöperative spirit. It is the one factor which has allowed us to carry out the plans of the originators and to make such innovations and experiments as we believe will improve the curriculum. I will speak about a few of these innovations more in detail later, but I want it clearly understood that it is not these changes and departures from the ordinary curricula which are the important things in this course, but rather the real coöperation which the General Electric Company has offered us. Do not think, however, that this company has an unselfish motive in this work. The officials of the company frankly confess that they are pursuing this work because they believe that by this method they can procure the future engineers who will be so badly needed by the company and by other industrial concerns in the near future. It was because they believe that this is the best way to secure these men that they have entered into this scheme, and after one year's trial they report that they are more convinced than ever of the value of coöperative education conducted along these lines.

Perhaps the spirit in which the work is being done is most clearly manifested in the attitude which the officials of the company are showing in their lectures on manufacturing methods. Once a week one of the superintendents has the students come to his office and, in an informal way, talks to them for an hour concerning the details of the work of which he is in charge. This feature was introduced into the course at the suggestion of one of the superintendents and is given entirely upon the superintendent's own time. Some of these men have already prepared six or seven talks on their work, many of them illustrated with lantern slides; some have prepared exhibits of the work in the shops, showing the material in the different stages of manufacture, and arranged in order of the process. Others have arranged to have the students come to their shops in small groups in order to follow through the manufacture of some typical article of their product so that the students may become familiar with the output and the processes before the lecture is given. When one stops to think of the amount of labor and time that is involved for the superintendent who does these things, he can appreciate how the spirit of the originators of the course has permeated the personnel of the works. It also has entered into the attitude of the workmen themselves. I have been surprised, and, I assure you, agreeably surprised, to receive rose-colored reports from the students concerning the willingness of the workmen to help them obtain information about the plant. It would seem impossible for twenty-eight different personalities to mingle with the men of the shops and offices for a whole year and to have not one of them report cases of grouchiness on the part of the other employees of the company. But such has been the case. In fact, the boys report that many times they are embarrassed by the extreme courtesy and eagerness of the men to show them all about the work and to demonstrate and explain the details of particular processes. All these things, it seems to me, show the degree to which the company has entered into this scheme as a purely coöperative project.

Of course, you must also appreciate that the students have done their share in coöperating. They have in every case entered into the spirit and work of the shops and offices and have quickly become a part of the company. We have paid particular attention to impressing upon the students the great factor which human engineering plays in their chances for success. They are impressed with the fact that nothing is of more importance than to understand the sterling qualities of the men with whom they are working, to study and learn how to adapt themselves to the personal characteristics and eccentricities of the various foremen under whom they are working—that these things will be of the utmost importance when they are in a position to direct the work of others. So during their sojourn at the shop they get experience not only in electrical engineering but also in human engineering and each man's progress along this line is followed carefully by those in charge of the course. Do not get the idea from this, however, that the students are in any way coddled. Here is an excellent chance for them to learn to stand on their own feet with all kinds of fellow workmen and all kinds of foremen, and they are compelled to do so. Of course, they make mistakes and occasionally get into trouble, but it is better for them to make mistakes and get into these few troubles while they are still students under the supervision of the instructing staff of the plant and school rather than later. Each mistake is used as material to impress upon them the value of human engineering. They are thus able to learn valuable lessons without having to suffer too seriously from the mistakes.

Great credit belongs to Mr. Magnus W. Alexander, whose initiative was a principal force in the origination of the plan, and to Mr. C. K. Tripp, Superintendent of Apprentices, of the General Electric Company for the excellent work they have done along these lines. They have worked out highly successful methods for utilizing in the most practical way all the opportunities which the shop work affords for education and training in the human aspect of the job. To be sure, they have thrown themselves enthusiastically into all activities of the work and have brought to the task experience of twenty years in training executives. But in the development of the human side, I believe they have contributed a particularly valuable feature to the educational program of engineers. This discussion is a little aside from the point I was trying to bring out, but I believe it shows how the far-sighted policy of the Coöperating Company allows us to broaden the training in every desirable way.

As the third point of difference from other coöperative courses, I will mention the continuity of the theoretical studies and humanistic subjects. All through the course, both while at the institute and during his sojourn at Lynn, the coöperative student is pursuing the study of electrical engineering theory. At this same time he is taking courses in the study of English. While the main purpose of the latter is to train the engineer in more effective speaking and writing, it also affords opportunities for enlarging his vision and creating new interests. Accordingly when a student goes to the works he continues the study of electrical engineering just as though he were at the institute. During this period, however, we have found that he can comfortably cover only about half as much ground as he would in a like period at the institute. This schedule calls for six hours of study per week and three recitation hours for the two subjects, electrical engineering and English. Thus including the one hour lecture given by the shop superintendent each week, the students spend four hours per week in recitations or lectures. Their schedule at Lynn, therefore, comprises the following:

48 hours per week in shop or offices,
4 hours per week in class room work.
6 hours per week in preparation for class room work.

This schedule allows the student to do all his study in three evenings a week and yet get to bed at half-past nine. There is still left for him three weekday evenings, Saturday afternoon, Sunday and Sunday evening, for collateral reading and recreation. At the institute his schedule calls for a total of forty-eight hours per week in class room and preparation. Thus while he is at the works the student's weekly schedule is increased from forty-eight to fifty-eight hours of a combination of shop work and mental work. This schedule at the works has proven of advantage in two ways—it has made the period at Lynn contribute to the student's technical knowledge and literary appreciation, and at the same time has kept him in the pink of condition mentally. The scheme may be compared to the system of physical training in which intense physical exercise is alternated with periods of lighter but regular exercise, which keeps the athlete at all times on the tip of his toes. It has been one of the most gratifying results connected with the work to find that our fondest hopes in this direction have been fulfilled. Members of the instructing staff at the institute have commented upon the fine mental condition of the classes returning from their thirteen weeks' stay at Lynn. I believe the opinion is unanimous among their professors that these students are wide awake, have acquired a keen appetite for study and are entering into their work with a new zest. In short, they have what the boys call "pep."

Inasmuch as the material used in the study of English and the method of conducting the English classes is unique, I believe a word concerning this work would be interesting. It is a well known fact that engineering students as a class have an aversion to the study of English for its own sake. So it was felt necessary to arouse an interest in this work before starting it. A plan which was conceived by Professor H. G. Pearson, head of the English and history department at the institute was adopted. At the first session, letters from successful graduates of the institute were read to the class. These letters all brought out the fact that the higher the engineer rises in his profession, the greater is his need to be able to speak well and to write well. Several instances were cited where promising engineering projects were turned down by committees or boards of directors because the engineers back of the schemes were unable to present their side of the case effectively, while a lawyer who knew nothing about the engineering features was able to talk effectively and persuasively. The class was then formed into a committee or a board of conferees and the session, instead of being called a recitation in English, was called a meeting of the board. At each of its sittings one of the students presided, and two or three members, acting as a subcommittee, presented a report to the board and advocated its adoption. This report generally consisted of some engineering project. For instance, at a typical session, the class was formed into a committee from a manufacturing company about to build a machine shop of a given size, and requiring a definite amount of power for lighting, heating and driving the machinery. Two members of the class, acting as engineers of a company dealing in power plant equipment and supplies, put before the board the advantages of the company owning its own power plant. Two other members of the class representing the local electric power company advocated that the board purchase central station power. After the presentation of each side, the class discussed the matter and finally voted upon the question. The presentation and discussion were made without notes, except for numerical data, etc. At the close of the discussion an instructor in English criticized the session, taking up such points as the work of the presiding officer, showing how he might have avoided some of the difficulties he encountered, and how he might have more easily extricated himself from those he did get into. The effectiveness of the presentation of the subject was taken up from the grammatical, literary, and psychological standpoints, the discussion of the class was commented upon from the point of view of its relevancy, and the vote of the class was criticised as to whether or not the class had really voted upon the merits of the question. A member of the engineering faculty usually discussed the whole subject from an engineering standpoint, generally as to whether or not a fair statement of the facts had been made. At the succeeding session of the class, a written report was always handed in to the English instructor by the men presenting the projects to the class and by the secretary of the board. During the first period at the works every man in the class had an opportunity to serve on two subcommittees, to preside over the meetings twice, and act as secretary twice.

During the second period at the works, the sessions in English took a different tack. On the previous occasion, emphasis had been placed on effective presentation of engineering projects in the interest of some company for which the student was supposed to be working. During this term's work the emphasis was laid upon the effective selling of one's own services or on interesting capital in one's own project. The instructor took the pains to explain the purpose of this term's work before asking the students to write. He showed them that each letter and each article that they wrote was written for the purpose of producing a certain effect and everything in the letter or article should add to this effect; that any piece of writing was effective only in so far as it produced the result that was desired. A letter written for the purpose of obtaining the writer a job, is effective if it lands the job. A prospectus written for the purpose of selling goods, is effective if it sells the goods. In keeping with this idea, the instructor put forward as the aim of this term's work, effectiveness in writing. Every bit of writing done that term was to have a definite purpose and be written to produce a certain effect. Such exercises as these were used. "Write a description of a dusty room which will make the reader sneeze." "Write a letter asking for an appointment that will make the reader really desirous of seeing you." When the idea and aim of this course was understood, and the purpose of these themes explained, interesting writing competitions arose and work which formerly was looked upon as drudgery became an exciting contest. The class used as a textbook, examples of forceful writing contained in a volume of short articles by a well-known reporter.

I have dwelt at considerable length upon this first year's work in English because I am convinced of its importance to engineers. We still have two more years with this class in which to continue the work, and plans are being formulated to develop courses which will so appeal to the engineering student that he will put sufficient effort into the work to make it effective.

To go back to the differences between this coöperative course and others, I should like to mention as a fourth point the provision which is made for further liberalizing the engineering student's education by means of collateral reading. The plan which was adopted for housing the men lends itself very readily to the arrangements for this work. The students, while at Lynn, live together at the Thompson Club, a fine old residence which has been remodeled into a club house with private rooms for individual study, an assembly room for class work, a library, a billiard room, shower baths, etc. The club house forms a center of activities and here all class exercises are held. Advantage was taken of this arrangement to equip the library with a wide assortment of technical books from the institute library, and arrangements were made with the Lynn Public Library whereby several shelves are kept filled with books on all sorts of subjects and in many fields of literature. These books are exchanged from time to time for others suggested by members of the class and by the instructing staff. The sole aim of this part of the library is to make the appearance of the books so attractive and the subject matter so interesting and so accessible as to invite the men to use them. So important do we consider this side of the engineer's education that his program has been laid out with the definite purpose of giving him an opportunity for reading outside of the prescribed courses. We thoroughly believe in the desirability of creating the habit of general reading on the part of the engineer. This is in line with our conviction that if the men with engineering training can be induced to bring this training to bear on public questions and civic affairs, a great dynamic for good will be put into public life, a dynamic which has behind it all the power of a highly trained mind. This club library, together with the material used in the English course, affords only a beginning, but our efforts have met with gratifying results. At this early date there is evidence of an increased interest in public affairs and a growing appreciation of good literature.

The fifth point of difference which this course offers is the intense spirit of loyalty which has been inculcated in the members of this course; a loyalty to one another, to the institute and to the coöperating company. Several things have contributed to bring these conditions about. First, the closest connection has at all times been maintained between the institute and the group at the plant of the coöperating company. On three or four days each week a member of the electrical engineering department of the institute spends a half day at the plant visiting the various shops and offices to which the students are assigned, or to which they are to be assigned. In this way, as well as by the direct contact which is maintained in the two sessions a week in the class room, the student is made conscious of the supervision which the institute exercises over his work in the shop. To further decrease any sense of separation from the institute, there are always to be found on the library table copies of *The Tech* and *Technology Review*, two student publications of the institute, which help to keep the students at Lynn in close touch with the student life at Technology. Another feature which has not only kept the men closer to the institute, but has made a closer bond between the members of the two groups of coöperative students, has been the practice of having the group at the institute visit the Lynn works on evenings when the officials of the company deliver their lectures on manufacturing methods. During good weather the department of electrical engineering furnished automobiles for the transportation of the men. The members of the group at Lynn were also encouraged to make frequent trips to the institute and to enter into the student activities there whenever it was possible. For instance, on "Tech Night" at a Boston theatre the group at the works attended in a body.

On other occasions, dinners were arranged at which one of the men acted as toastmaster and others were called upon for ten minute after dinner speeches. These dinners not only formed very pleasant occasions and knit the class closer together, but gave the students opportunities to try out the effectiveness of their English course. I know that the older men in the audience who have been bored nearly to death by after-dinner speeches will not very readily give their approval to this feature, but it must be remembered that young men get a good deal of enjoyment out of such affairs and these dinners were really welcomed as a pleasant break in the routine.

The fact that these students are all taking the same course at the same institution, and are working for the same coöperating company, and finally living together under the very pleasantest conditions, quickly develops this three-fold loyalty. It is this loyalty to the institute and to the company, founded upon the student's conviction that both the institute and the company are planning the work for his highest education and best welfare that in the last analysis must be depended upon to produce results in the way of conscientious and intelligent effort in delivering an honest day's work in the plant and in doing the full quota of study. Finally the coöperating company relies upon this loyalty to influence some of the men in each class to remain with the company after completing the course.

As the sixth point of difference in conducting this work should be mentioned the fact that throughout the three years students are kept in the plant of the same coöperating company. Under the right conditions we feel that this has its decided advantages, because once the officials of the company have determined upon such a policy as the General Electric Company have determined upon in connection with this course, this policy can be maintained and pursued in every department through which the students pass. Of course the company must be of such a size that it has all the departments in which an electrical engineer needs experience. We are fortunate in our coöperating company. It designs and manufactures electrical and mechanical machinery and apparatus of nearly every description and of the widest range of capacities, and many mechanical devices large and small, some of the most intricate design, the annual selling value of which exceeds two hundred and fifty million dollars. Thus we are able to offer the student a wide choice in the departments in which he is to get his experience as well as in the particular branch he desires to specialize in. This arrangement has the advantage of offering the student the same diversity of work which a large number of smaller companies might offer him, without the disadvantage of a lack of coördination in details and in educational ideals.

The only remaining point of difference I wish to call to your attention is the unusual amount of theoretical work in the course and the fact that a Master's degree is awarded by the institute upon the completion of the five years' work. From the beginning of his freshman year to the end of his postgraduate year, the student pursues one course after another in mathematical physics. In the middle of his sophomore year he starts his work in the principles of electrical engineering and continues it without a break four terms a year for the remaining three and one half years of his course. During the last year the work at the institute is composed of advanced research and creative design, while at the works the student is given experience in the research laboratories of the company, or upon important work in the engineering and manufacturing offices. For a successful completion of this course the institute confers the degree of Master of Science, The degree of Bachelor of Science, conferred as of the year preceding the conferring of the Master's degree, is associated with the Master's degree. In this way the institute shows its appreciation of the value of advanced theoretical training combined with practical experience, which has been intelligently planned and carefully supervised.

THE CONFERENCE BETWEEN REPRESENTATIVES OF INDUSTRY AND EDUCATION, HELD AT DREXEL INSTITUTE.

BY S. P. CAPEN,

Director American Council on Education.

America had no sooner begun to mobilize for the war than it was apparent that whatever surplus of highly trained men existed would shortly be used up. The matter became the object of very serious study at the hands of several groups of people. One of them summoned by the Council of National Defense worked under the chairmanship of Dean Bishop, the Secretary of the S. P. E. E., and developed the outline of the policy for supplying the deficiencies which was later adopted by the War Department.

The war did not end the emergency in the field of higher training. Indeed, there exists today a more serious numerical shortage of young men and women qualified to enter the management end of industry and business than at any previous time of which we have record. The situation is full of portent for the nation. It cannot be remedied over night, but the application of as speedy a remedy as possible is a matter of national concern. No one can be indifferent to it. It is, of course, of the foremost urgency to the leaders of industrial enterprises and to those charged with conducting higher instituions, especially technical colleges.

A study of this situation over a series of months led Dr. Hollis Godfrey, President of Drexel Institute, to consider the advisability of calling a joint conference of educators and industrial leaders. A fitting opportunity presented itself in connection with the annual meeting of the Technology Clubs Associated, which was held at Drexel Institute, March 26 and 27, 1920. This meeting would be, in any event, frequented by representatives both of business and of education. Dr.

Godfrey therefore extended the list of invitees to include a large number of educational and industrial leaders who had no connection with the Technology Clubs.

Representatives were present from the following industries: Rubber, textiles, cotton finishing, shoes and leather, machinery and metals, paints and oils, paper, and public utilities. On the educational side there was a committee of the American Council on Education specially appointed to attend the meeting, and a large number of delegates from leading colleges and universities.

The purpose of the meeting as stated in the announcement was to "write a joint specification of the present-day educational needs of American commerce and industry and the expression of those needs to the higher institutions of the United States." In other words, it was proposed to meet the present emergency in a manner similar to that in which the war emergency was met. It was proposed that industry should define its needs, that higher institutions should accept the definition and should undertake to fill these needs. It was proposed finally to set up machinery which would enable the representatives of education and the representatives of industry to consult together periodically concerning the training of men and women for industrial and business purposes.

The discussion showed that before such periodic consultations could be provided for, there must be preliminary organization of the two parties concerned. Educational institutions and associations have already formed an organization which enables them to act with a certain degree of unity in a large national matter such as that proposed. The newly established American Council on Education is the central organization in which all of the chief national educational associations are represented. Its general object is to promote and carry out coöperative action in matters of common interest to the associations and institutions composing it. No similar organization exists in industry. The convention regarded the creation of such an organization as the first step toward the practical working out of the problems presented to it. It therefore passed the following resolutions:

Resolved, first, that each of the industrial groups represented in this movement for the writing of a joint specification by industry and the colleges appoint a committee, one of whose members shall act as a delegate to a *Central Council*.

Resolved, second, that this Council shall appoint a coöperating committee to act with the committee designated by the American Council on Education.

Resolved, third, that these two committees shall act as a joint clearance committee to advance the drawing up of specifications as to the qualifications of college trained men and women needed by the several industries, disseminating both to the colleges and the industries the information necessary to secure an increase in quantity and a betterment of quality of the output of the colleges.

Resolved, fourth, that Dr. Hollis Godfrey call the first meeting of the Council, acting as its temporary chairman.

The function of the joint committee provided in the third resolution above will be:

1. To define for the benefit of the industrial groups the type of educational specifications that will be acceptable to the colleges and that will fit the conditions of collegiate organization.
2. To review the specifications submitted by the educational committees of each industry.
3. To circulate them, with comment, among the higher institutions.

Some 150 industrial firms have made financial contributions for the furtherance of this plan. The necessary steps for the organization of the industrial council for coöperation with the colleges are now being taken.

EDITORIAL.

The Federated American Engineering Societies.—There was adopted in Washington at a conference of a large number of engineering societies, a constitution of the proposed national engineering organization known as "The Federated American Engineering Societies." The object of this organization is to further the interests of the public through the use of technical knowledge and engineering experience and to consider and act upon matters common to the engineering and allied technical professions.

This object, as stated, is of more than ordinary interest to the public as well as to the members of engineering professions. It states in a very practical way the fact that the engineer stands primarily for service to his fellowmen, rather than the desire to further his own advancement.

Including, as this organization undoubtedly will, practically all the engineering societies in the country and providing funds, although not ample to carry on the work of the organization, it possesses the elements of a great force in public welfare. It is unnecessary to call to mind the fact that the engineer usually shows so much interest in his own profession, especially the technical features thereof, that he fails to perform his duties as a public servant. This organization proposes to perform for engineering societies those public services for which the technical societies composing the organization have failed thus far to do. We can only hope that arrangements may be made by which the Society for the Promotion of Engineering Education may become a charter member of this organization. It seems to the writer that the duties of the organization must be to a certain extent divided among the various national and local engineering organization constituting its membership. Briefly speaking, the matter of education and its relation to the engineering profession should be considered by the S. P. E. E. In other words, the S. P. E. E. should constitute to all intents and purposes a standing committee on education of The Federated American Engineering Societies.

BOOK REVIEWS.

The Study of Electricity by the Deductive Method. GEORGE I. ALDEN, B.S., M.M.E., Worcester, Mass., 1919, Commonwealth Press. Pages 110.

The fundamentals of Electricity may be taught in many different ways, depending upon the ability and preparation of the student. All teachers of the subject make use of various mechanical analysis from time to time, the oldest and possibly the most common being the water comparison, most anlaysis being more or less specialized for the particular phase of the subject under discussion. The author in this work makes use of an endless flexible shaft revolving about its geometric axis as an analogy for electrical transmission of energy. The idea is developed in such a way as to make it applicable to the fundamental electrical and magnetic principles.
H. E. D.

Structural Drafting and Design of Details. By CARLTON THOMAS BISHOP, C.E., Assistant Professor of Structural Engineering, Yale University. First Edition, 1920, John Wiley & Sons, Inc.

This is a very carefully compiled book of 352 pages, 8 x 10 inches. It is intended for students in the elementary study of structural designing and drafting. Also as a convenient reference book for general use in commercial drafting rooms. There are sixty-four chapters of text including many illustrations and full-page structural drawings. Also thirty-six pages of tables and diagrams.

The book is well arranged as to sequence of subjects, manner of presentation, and amount of space devoted to the various subdivisions of the subject. It is clearly written and should readily appeal to any beginner in the subject. The illustrations and drawings have been carefully prepared and serve the purpose intended admirably. The author does not follow the case method extensively by presenting fairly complete designs of structures, but tends toward isolating the subdivisions and treating them independently. This can hardly be called a criticism in an elementary book of this character.

The tables and diagrams are very conveniently arranged and contain practically all of the standard data necessary in ordinary structural drawings. Several diagrams for graphic determination of resultants from two given components, and very complete tables and rivet values may be especially mentioned. J. H. S.

COLLEGE NOTES.

The Pennsylvania State College.—The summer course in industrial management will be given for the fifth consecutive year and is intended for superintendents, foreman, accountants and similar factory executives. It consists of an intensive course covering all phases of factory organization and management and will be given between August 9 and 21. A descriptive circular will be sent on request by addressing Professor Edward J. Kunze, head of the department of industrial engineering.

Wyoming School of Mines.—Dr. A. C. Boyle, Jr., for ten years professor of mining, metallurgy and economic geology, has been appointed geologist for the Union Pacific Railrad Company. He will resign his present position and will assume the duties of his new office about June 15. Mr. Boyle received his early training at Utah University, later attending Cornell University, and finally receiving the degree of doctor of philosophy from Columbia University School of Mines, N. Y., in 1913.